McBaine Water Treatment Plant Improvement Project

Pilot Testing and Alternatives Analysis

October 2021

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Water & Light

Presentation Agenda

- Project Overview
- Pilot Purpose and Findings
- Recommended Alternative
- Opportunities for Engagement

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Project Overview

McBaine Water Treatment Plant

- Built in **1970**
- Serves **50,300 customers**
- Covers an **89 square-mile service area**

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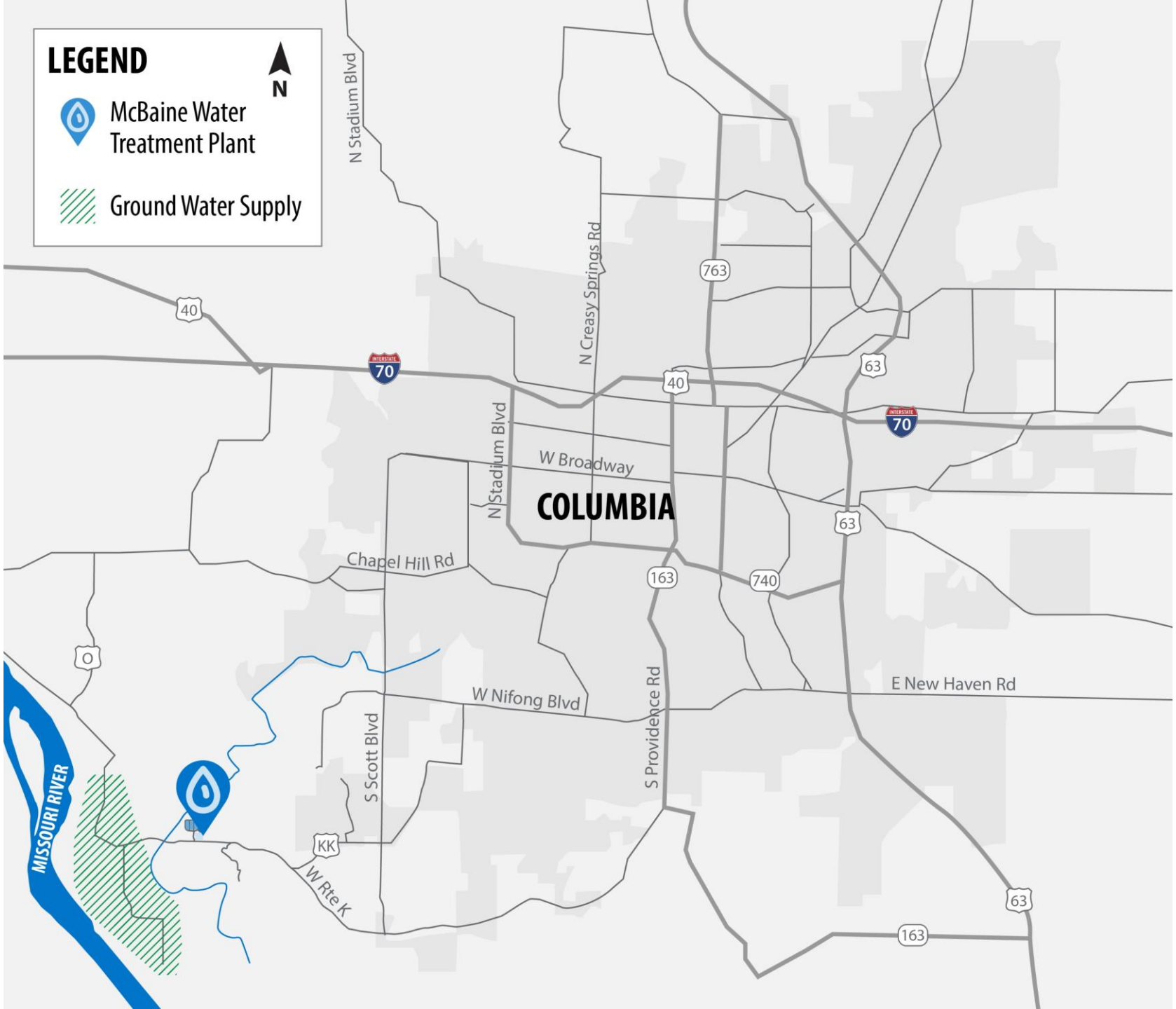

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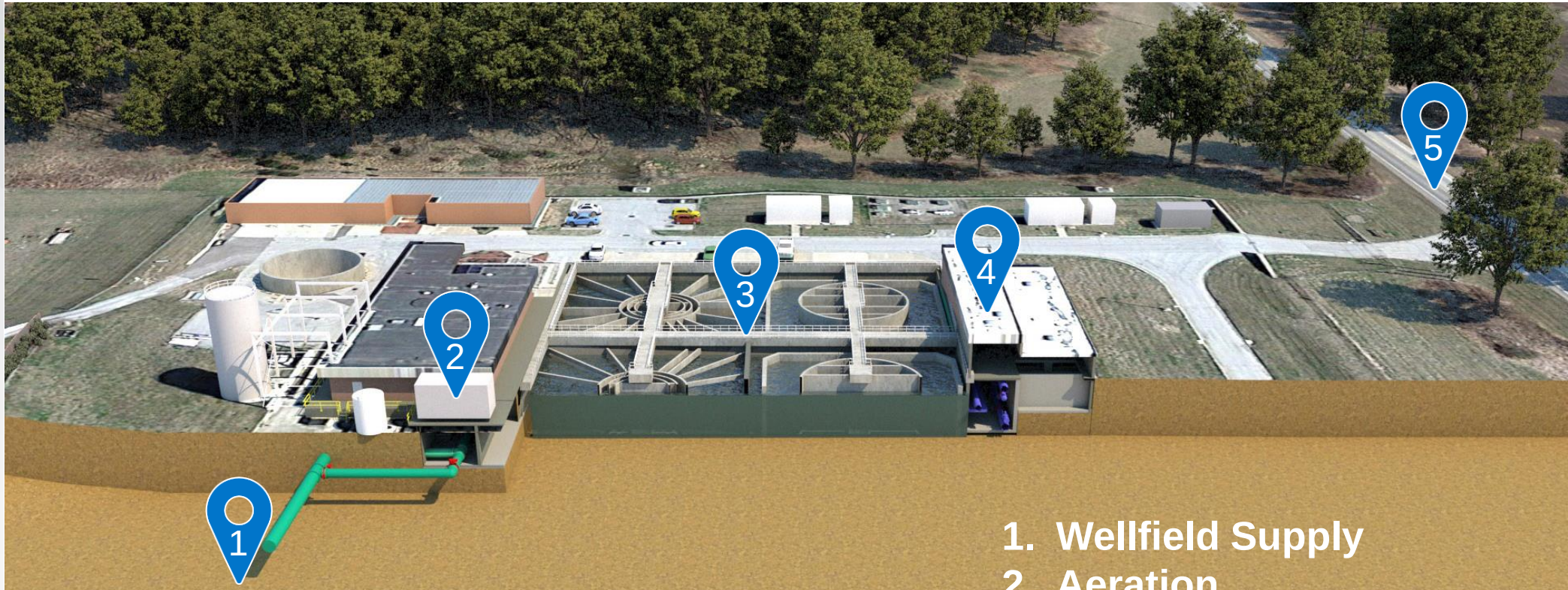
How we deliver clean, safe water



1. Wellfield Supply
2. Aeration
3. Water Softening
4. Filtration & Disinfection
5. Distribution

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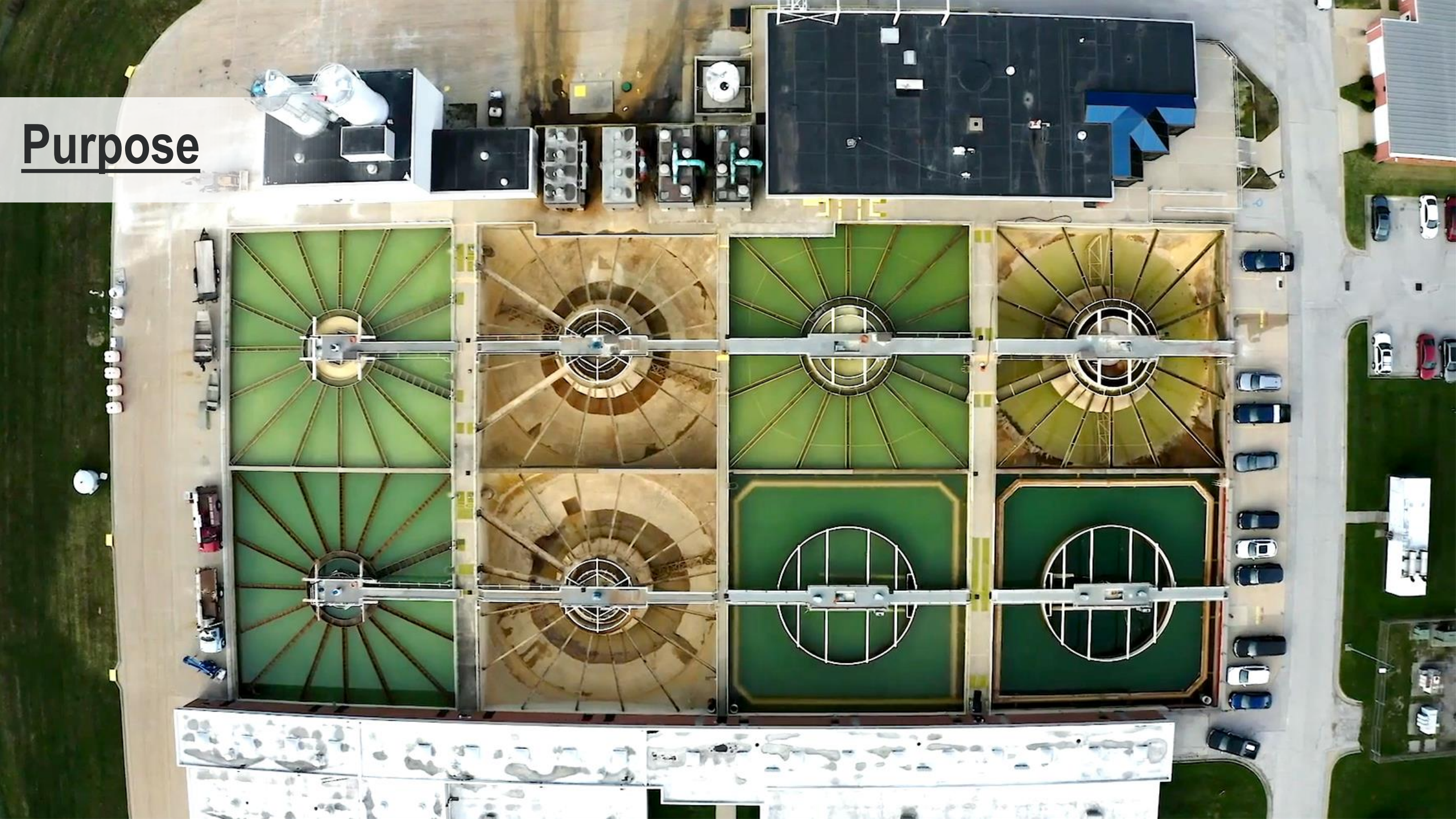
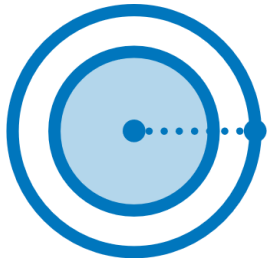
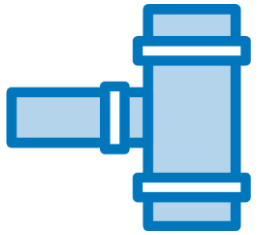
Purpose



Project Purpose



Replace aging infrastructure for enhanced reliability



Restore water treatment capacity

Improve current treatment performance

Prepare for potential future treatment enhancements

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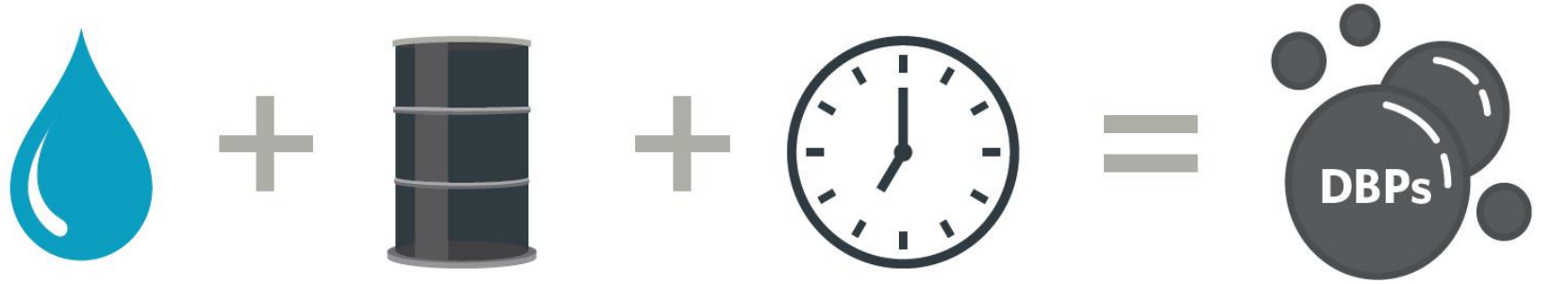
Disinfection Byproduct Formation



RAW WATER
- TOC
- Temperature
- pH

CHEMICAL DISINFECTANT
- Cloramines
- Free chlorine
- Ozone

TIME

DBPs
- Trihalomethanes
- Haloacetic Acids
- Bromate

TOC and UV_{254} are measures of DBP precursors and serve as treatment targets to reduce DBP formation in the system.

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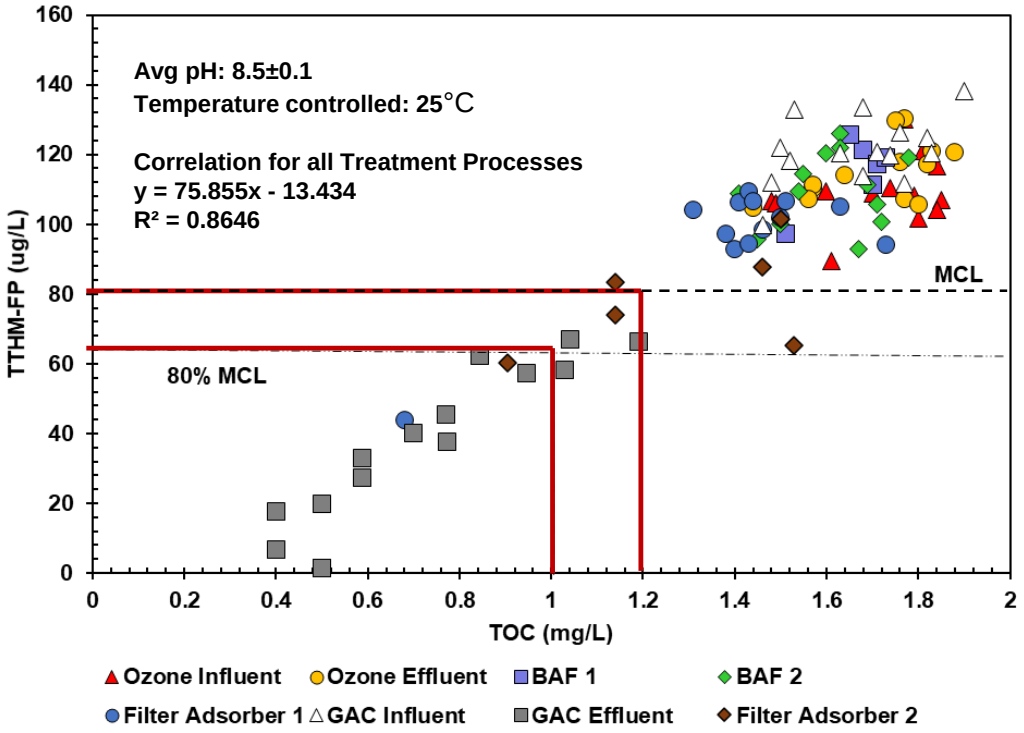
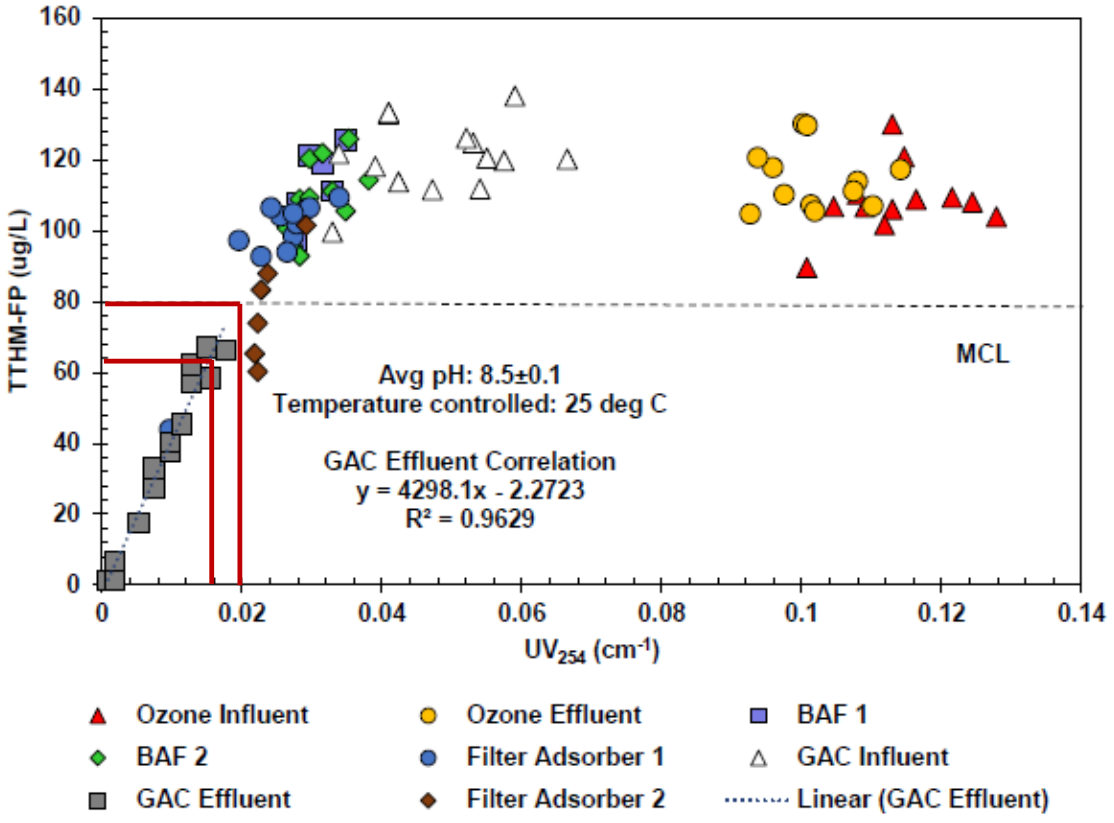
Disinfection By-Product Precursors & Surrogates





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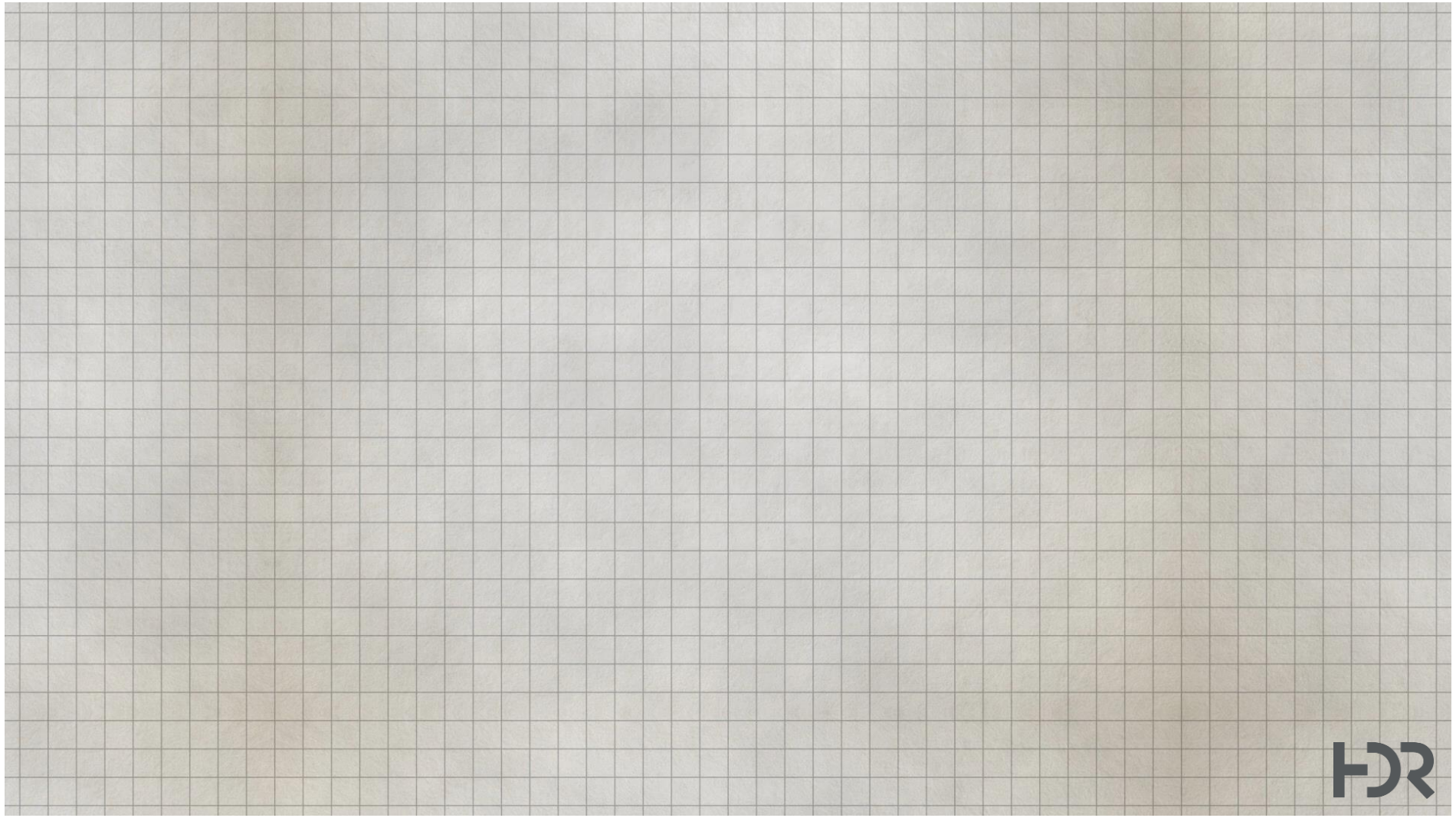
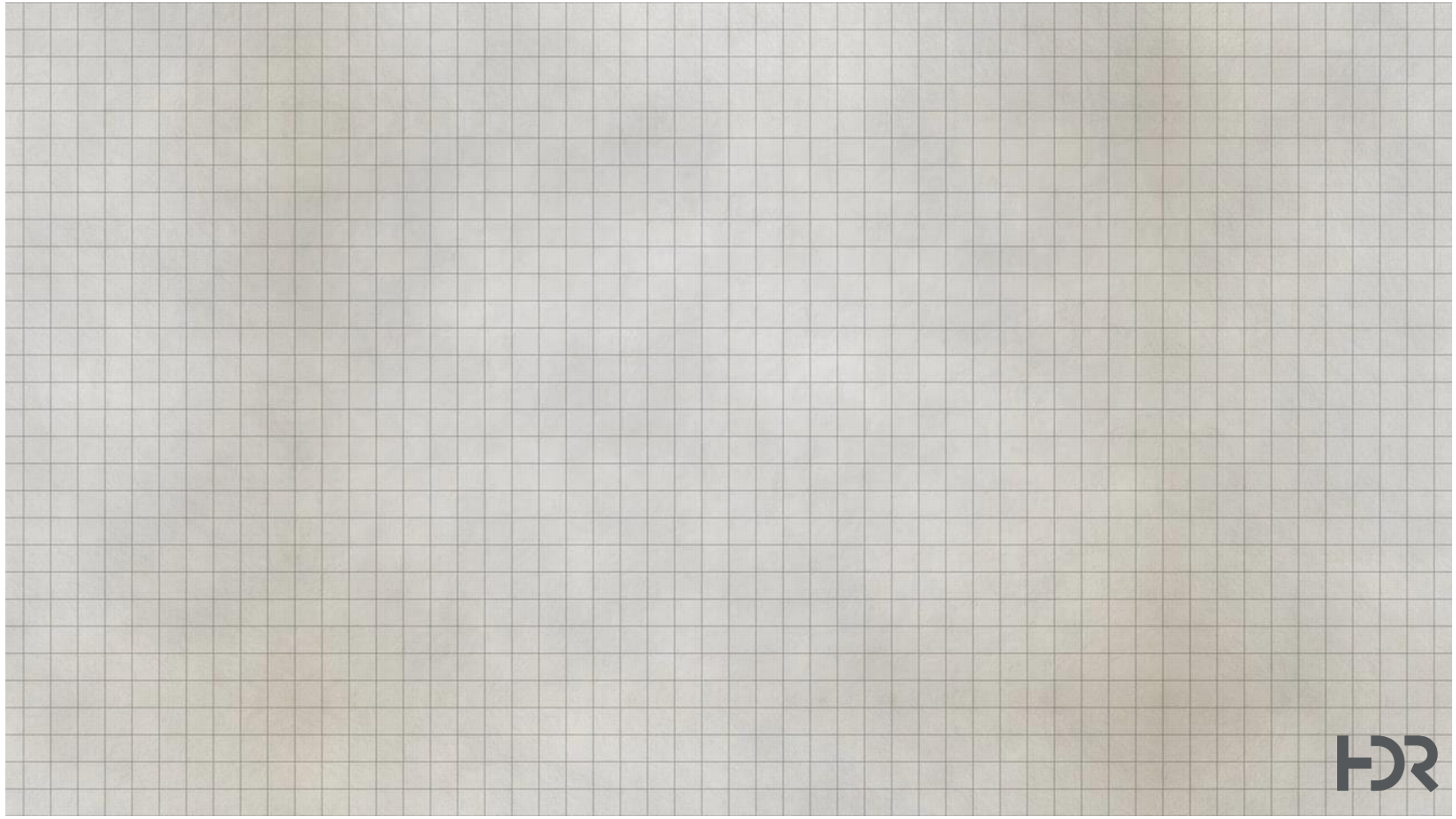
Granular Activated Carbon Adsorption



Ozone – Biologically Active Filtration



Pilot Study and Alternatives Analysis Treatment Processes

- Ozone – Biologically Active Filtration (BAF)
  - Integrate in existing filters or as post-filtration process
- Filter GAC Adsorbers
  - Replace anthracite cap in existing filters with GAC
- GAC Contactors
  - Add GAC Contactors following filtration
  - Add new High Service Pump Station (HSPS) & convert upcoming HSPS to Intermediate Pump Station

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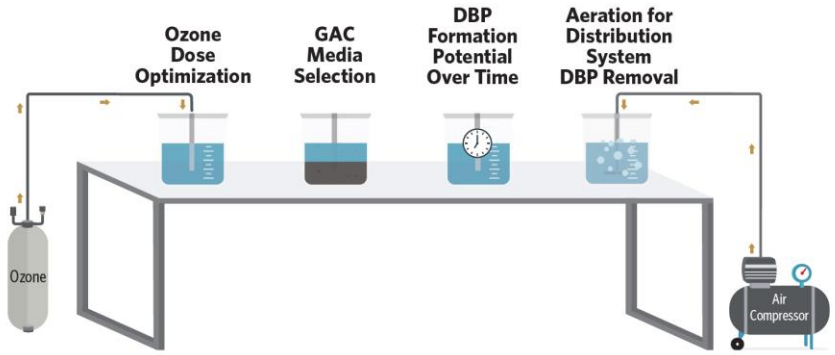
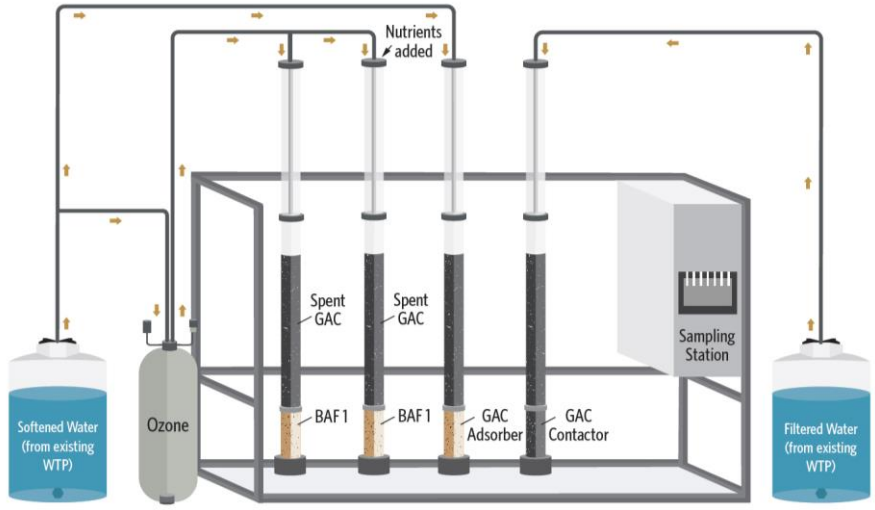
Alternatives Analysis Purpose

Evaluate process enhancements to meet long term water quality goals



Bench-Scale Study



Pilot-Scale Study

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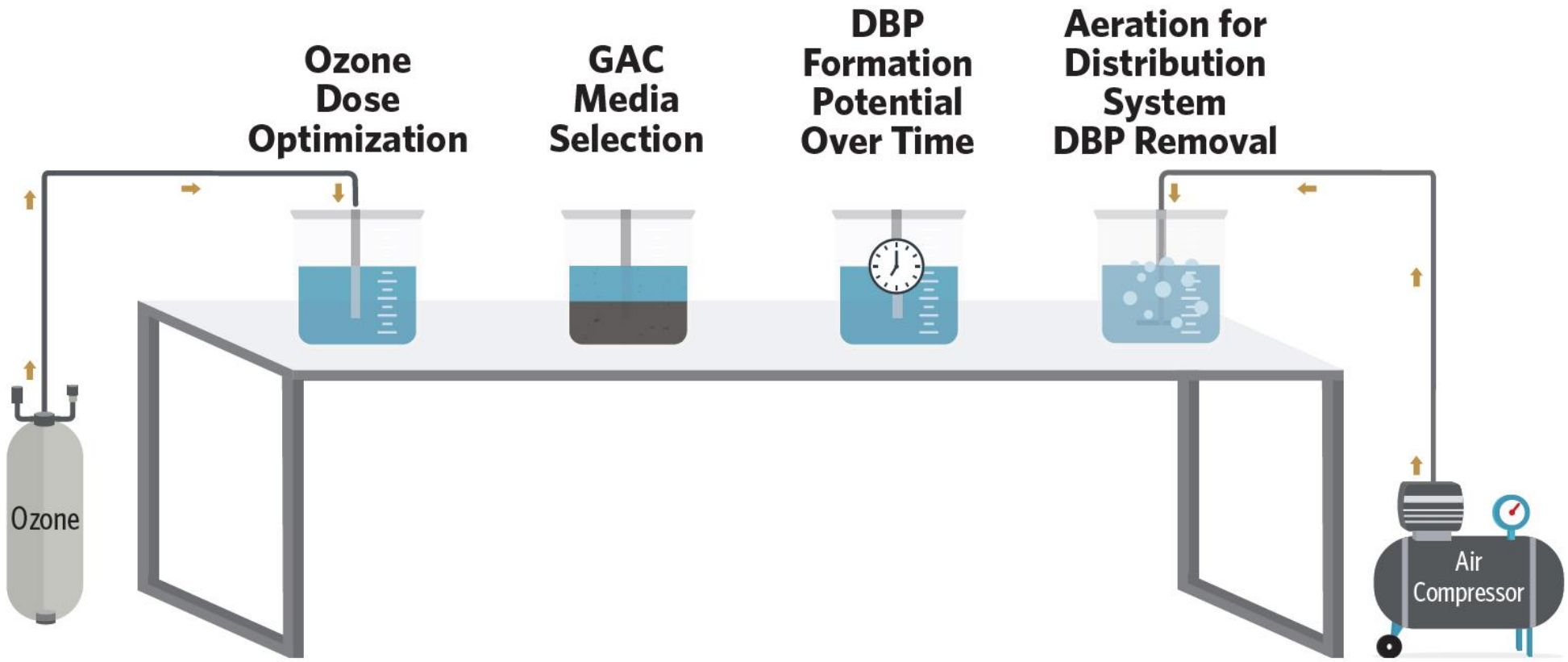
Bench-Scale Study



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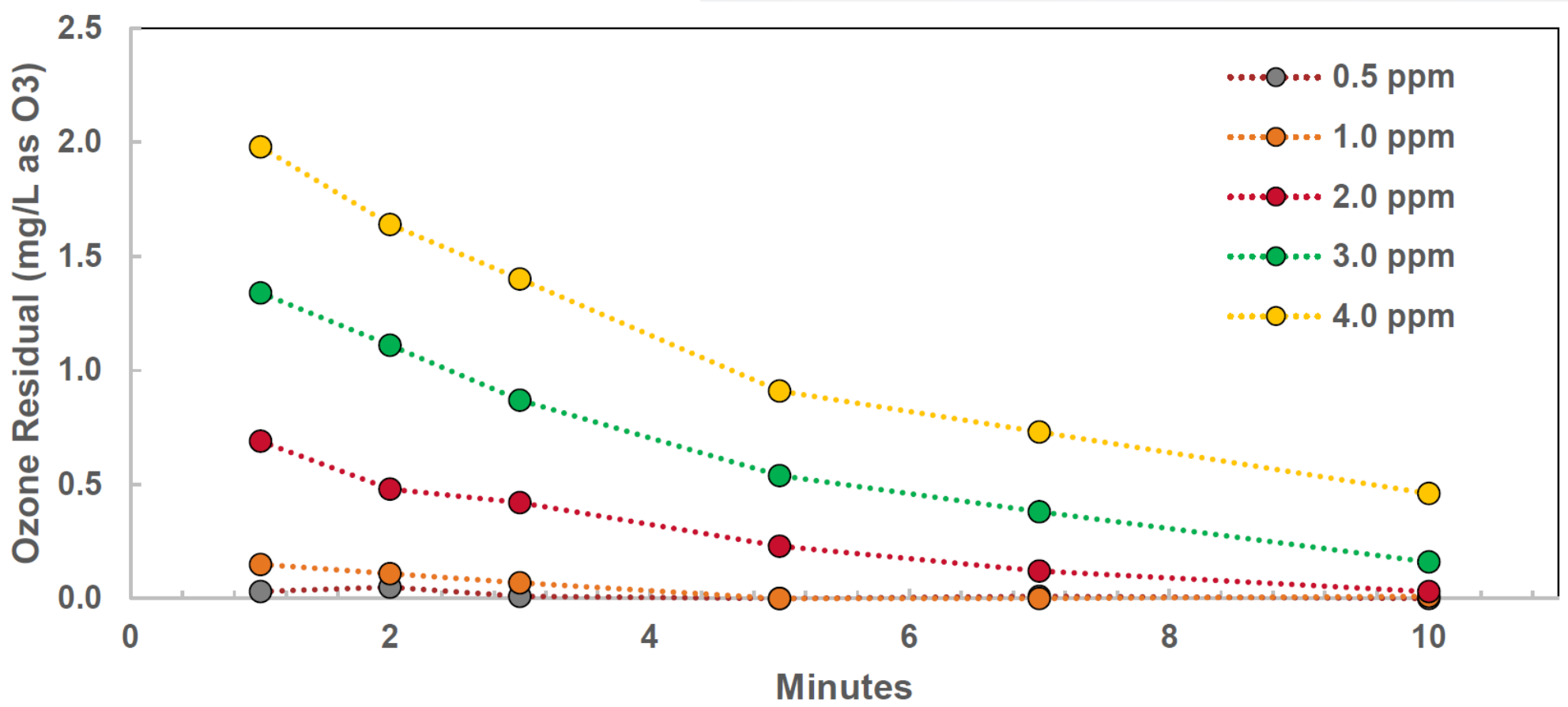
Ozone Dose Optimization



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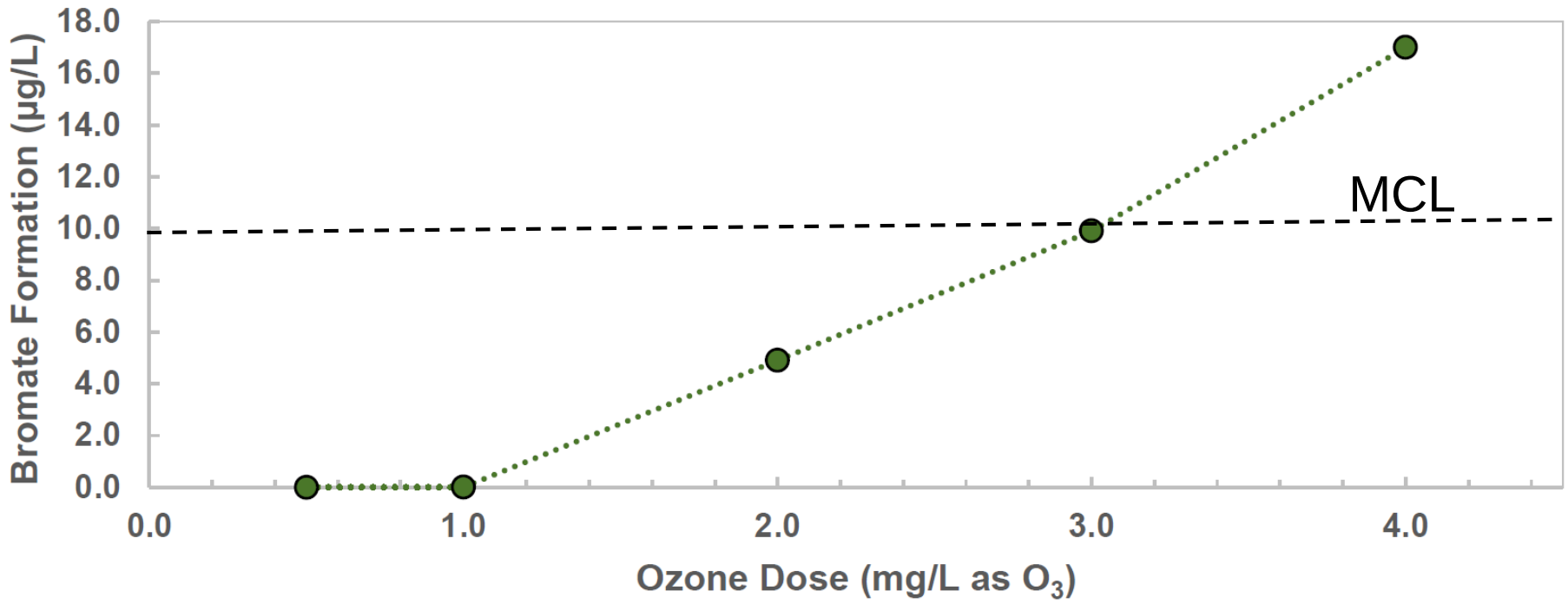
Bromate Formation from Ozonation



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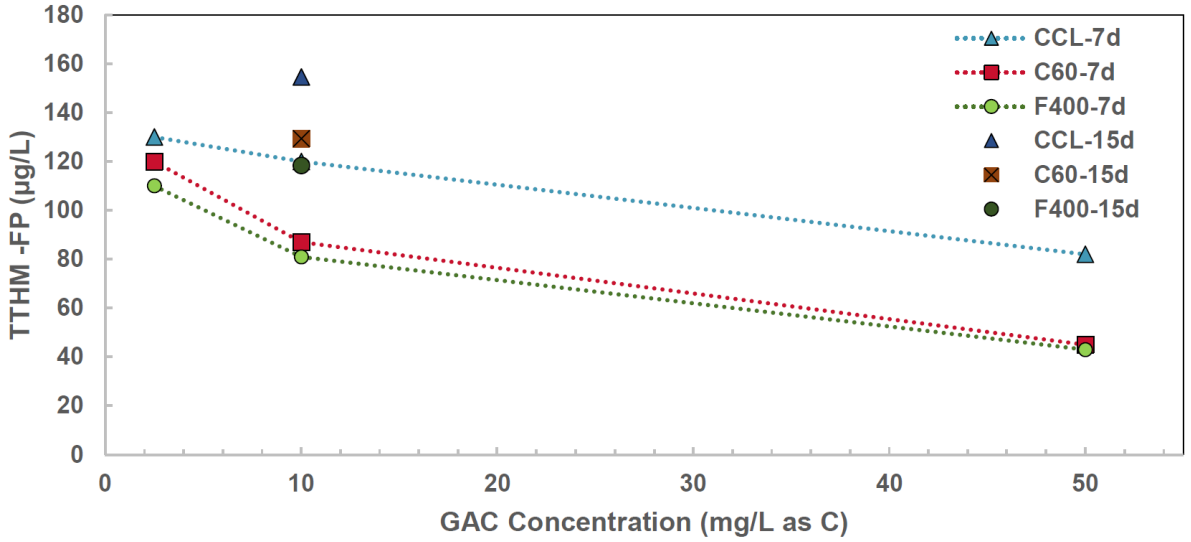
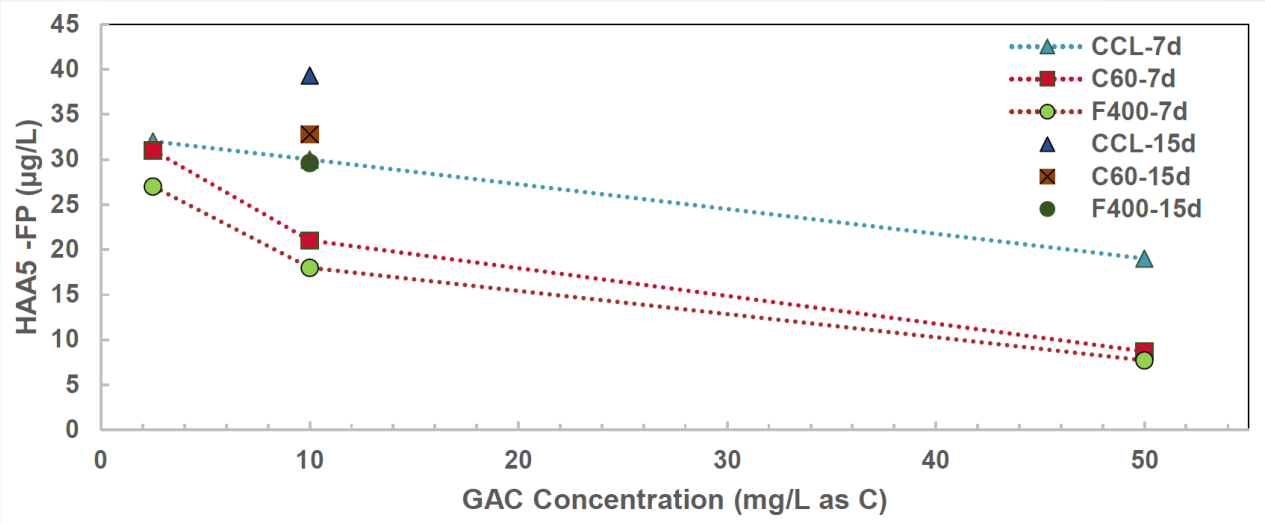
GAC Media Selection for Pilot-Scale Study



Total Trihalomethanes



Haloacetic Acids

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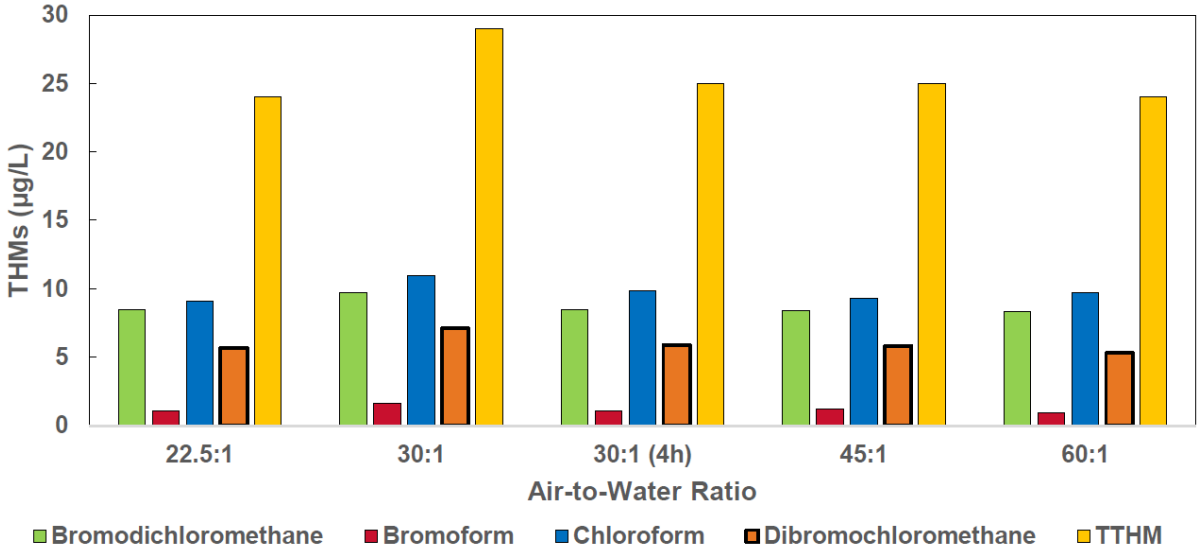
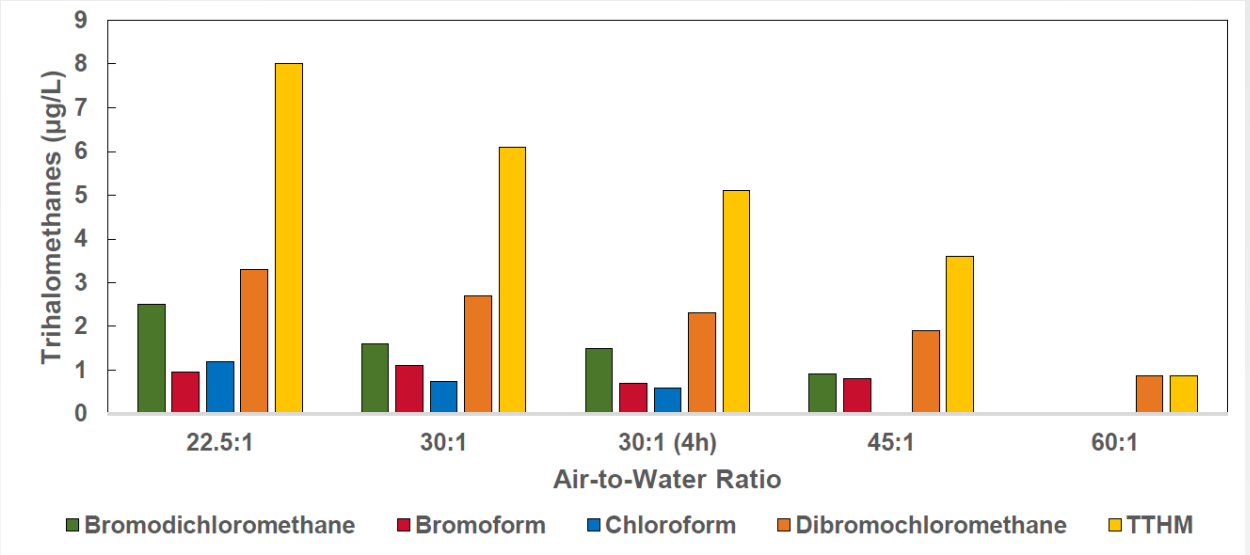
Calgon F400 selected as pilot-scale GAC Media.

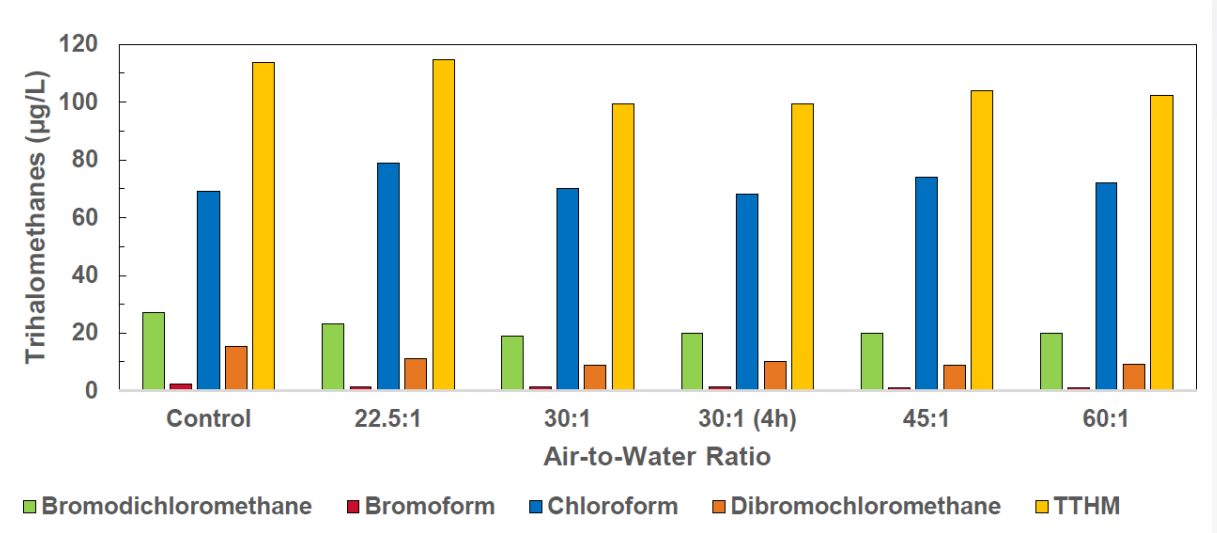
Air Stripping Testing to Evaluate Potential Effectiveness at Full-Scale



Prior to Aeration



After Aeration



After 7-days of SDS

TTHMs formation after aeration makes this alternative ineffective.

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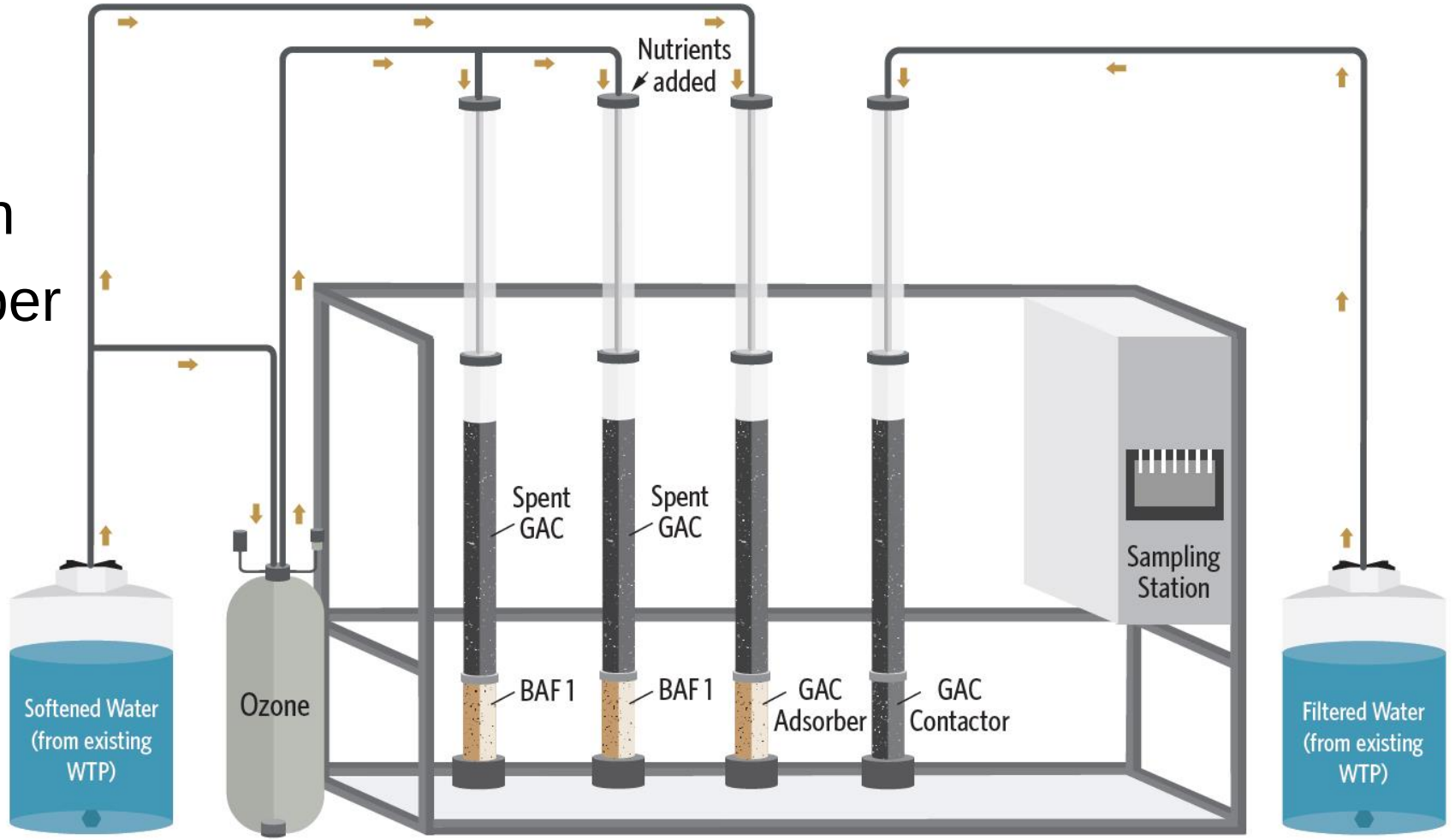
Pilot-Scale Study

1. Ozone/Biofiltration
2. GAC Filter Adsorber
3. GAC Contactor



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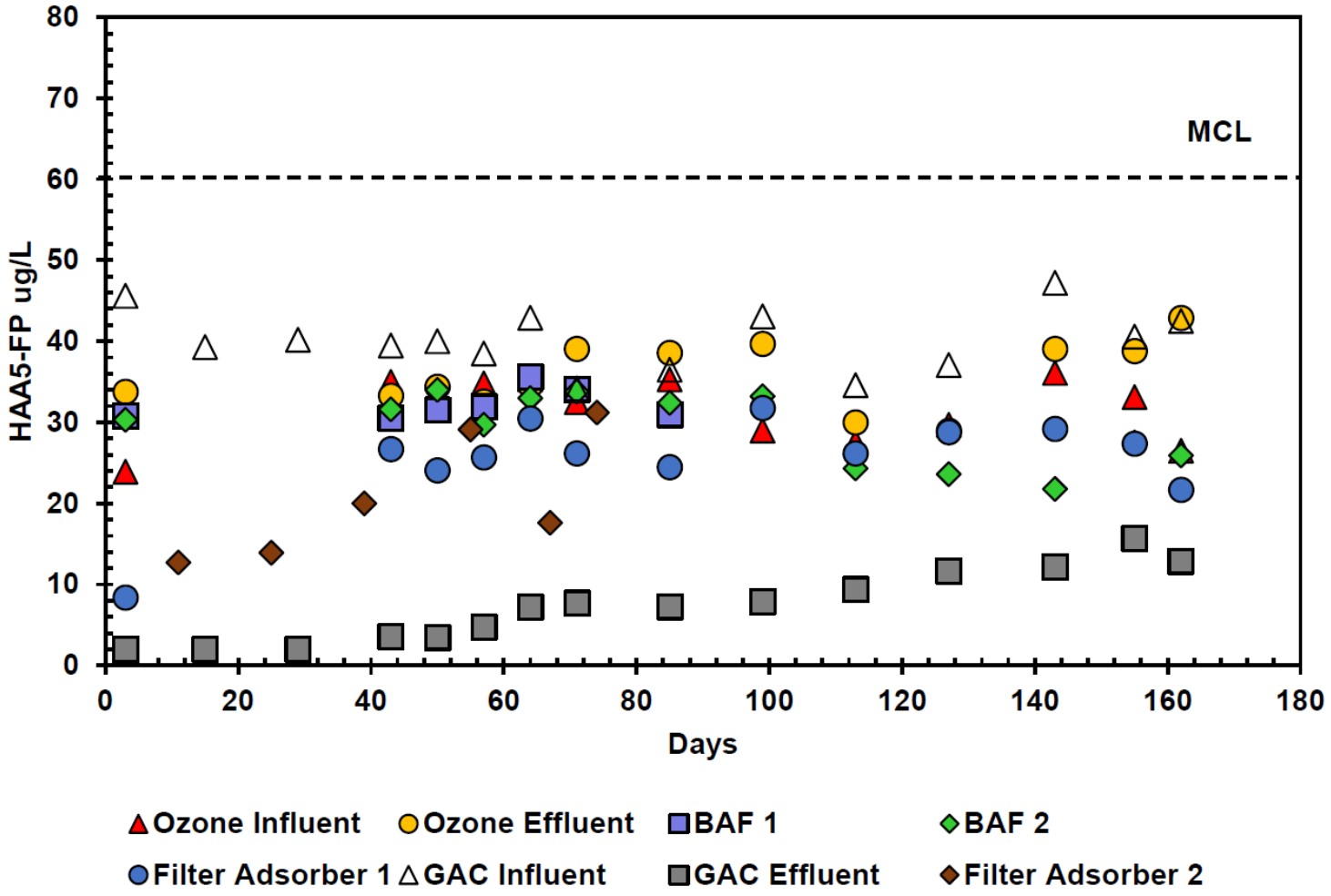
Haloacetic Acid Formation Potential of All Pilot Effluents



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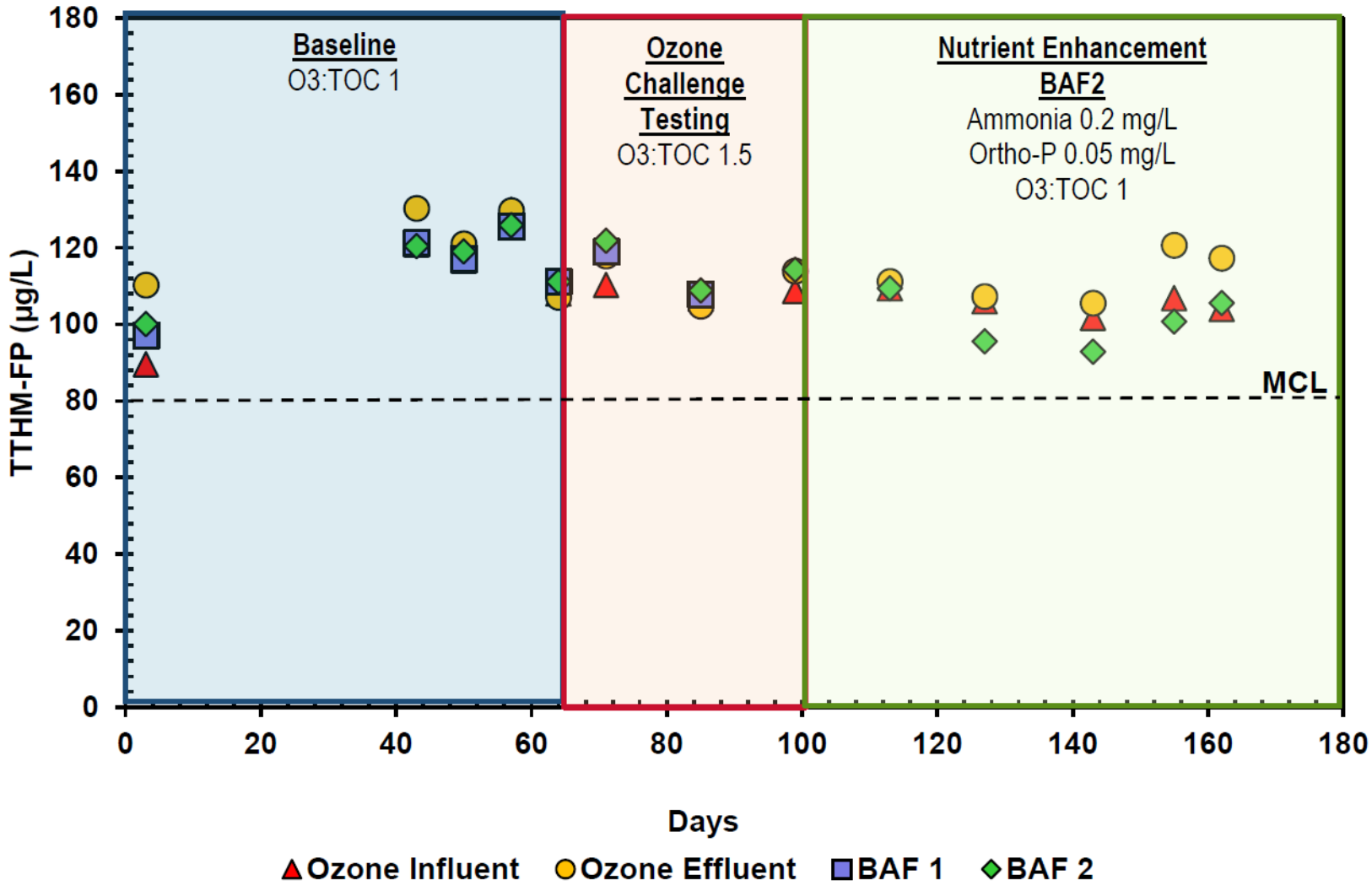
TTHM Formation Potential of Ozone/Biofiltration Effluent



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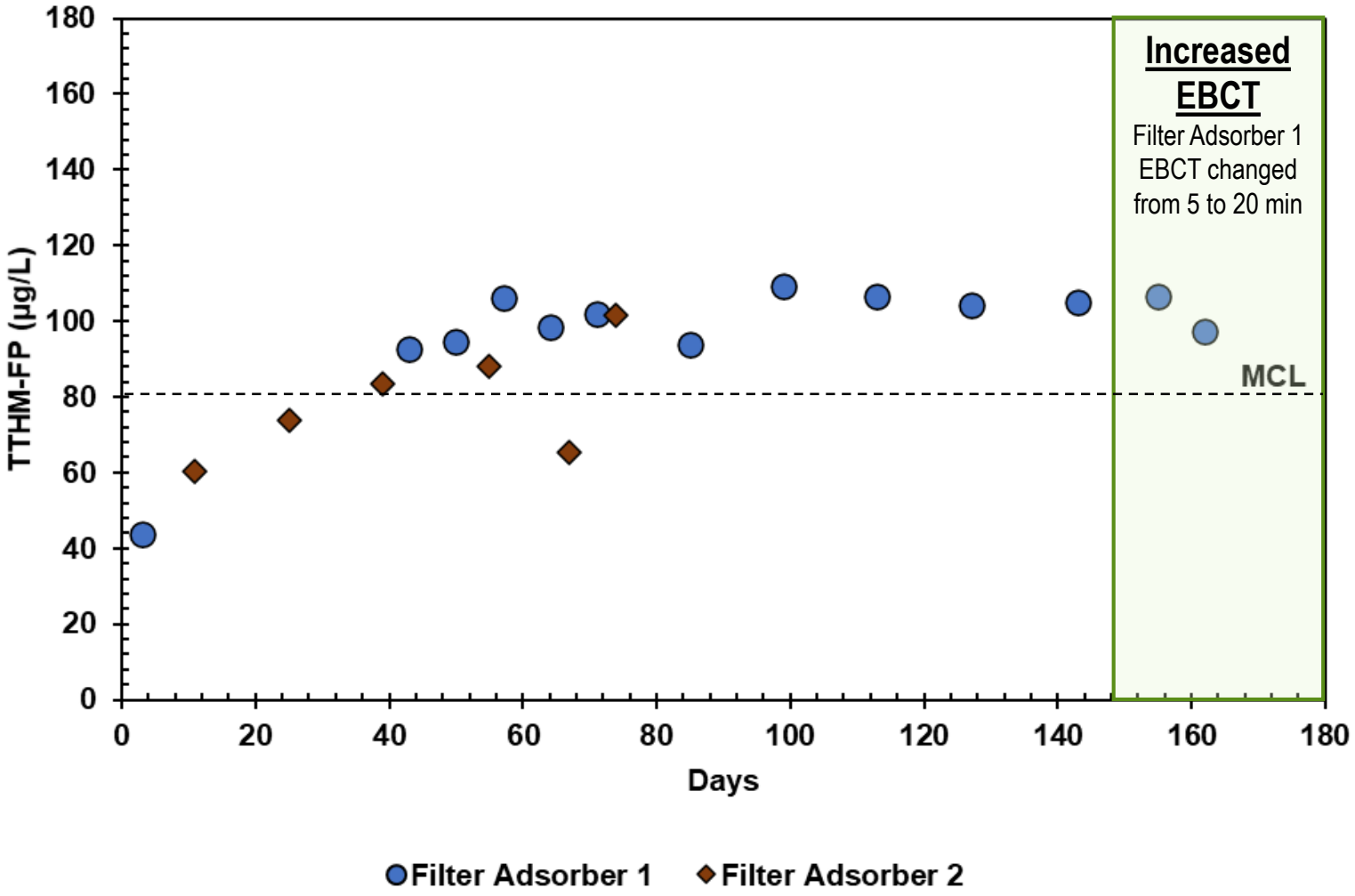
TTHM Formation Potential of GAC Filter Adsorber Effluent



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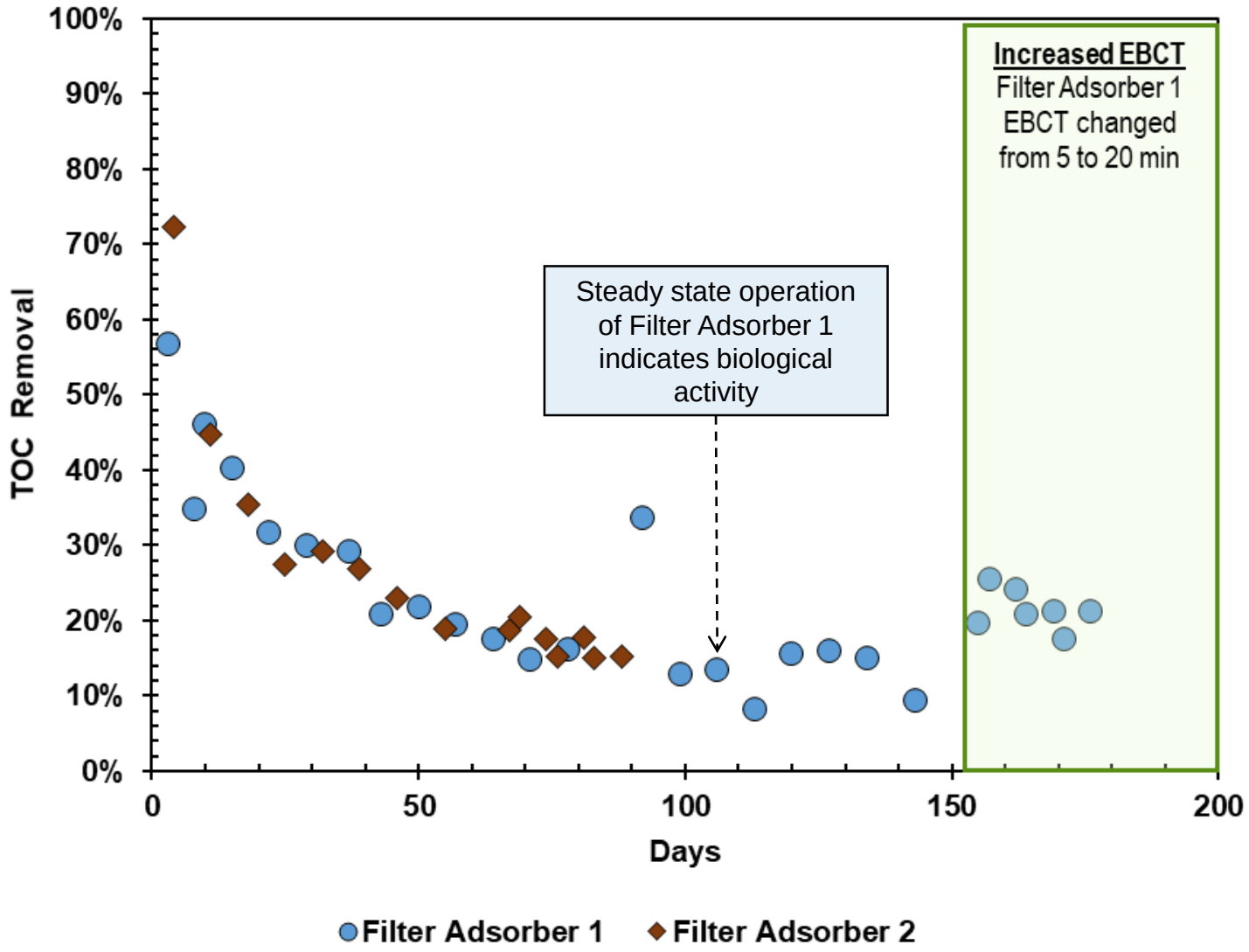
TOC Removal of GAC Filter Adsorber



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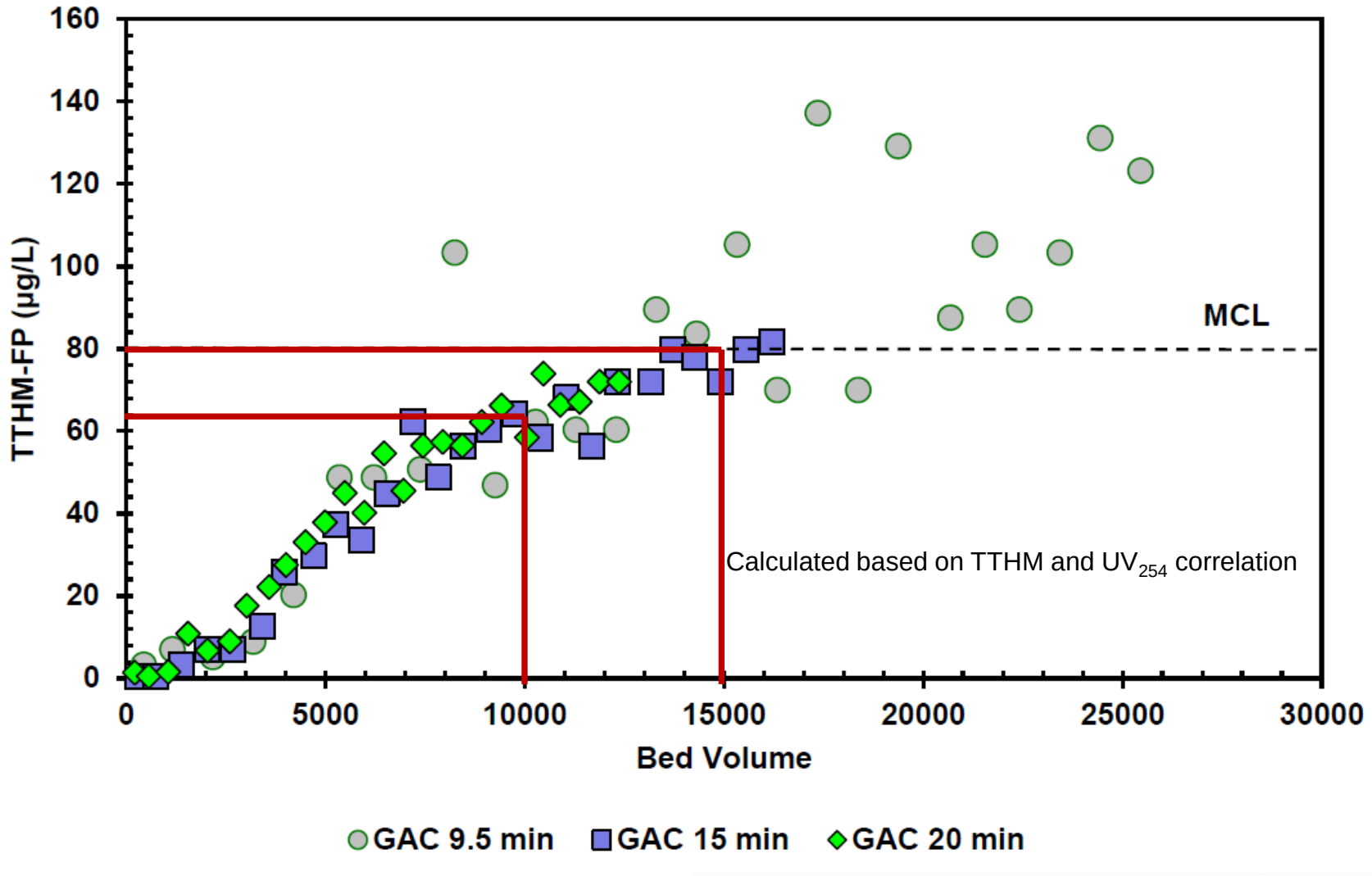
TTHM Formation Potential of GAC Contactor Effluent



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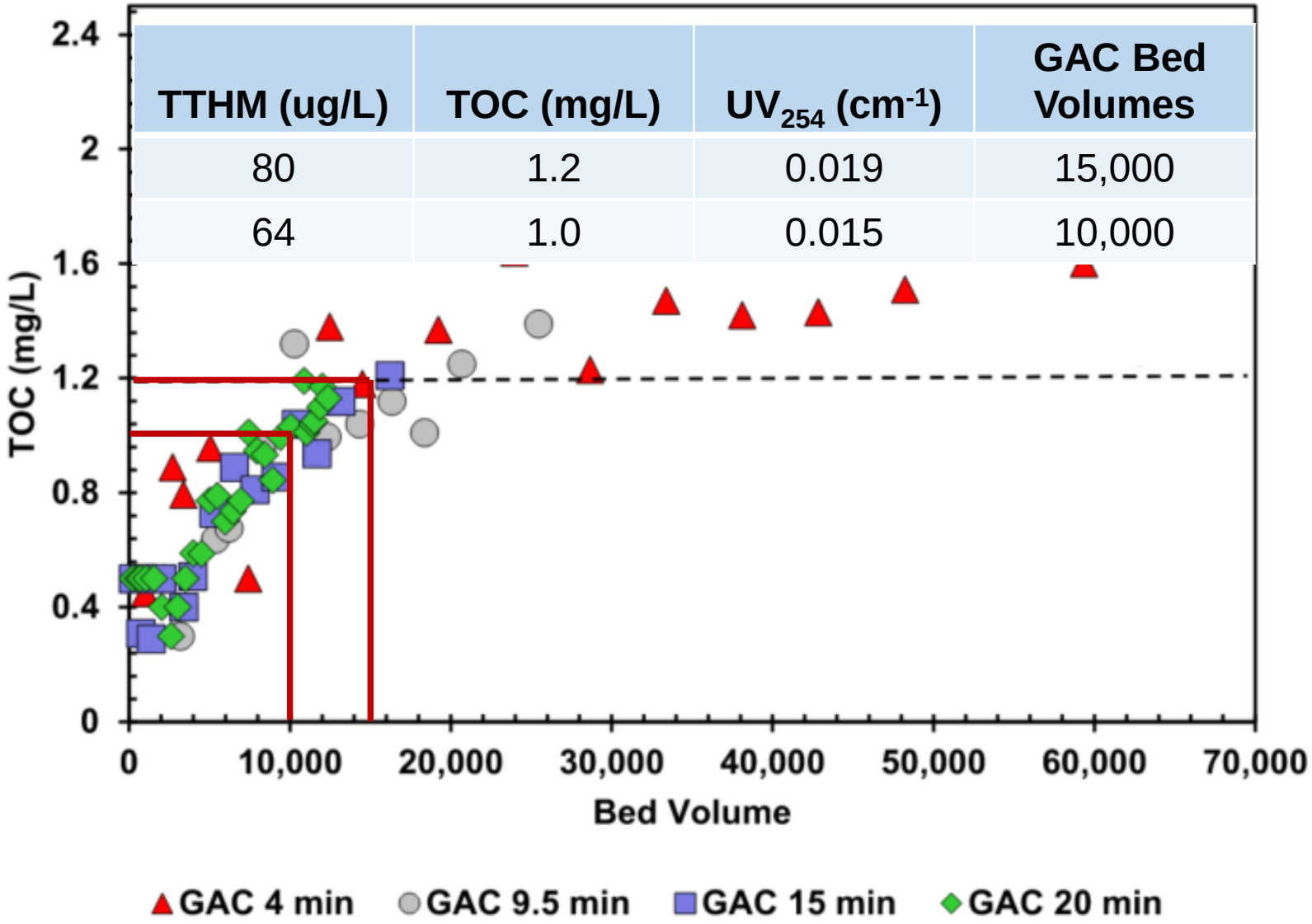
TOC of GAC Contactor Effluent

TTHM (ug/L)	TOC (mg/L)	UV_{254} (cm^{-1})	GAC Bed Volumes
80	1.2	0.019	15,000
64	1.0	0.015	10,000



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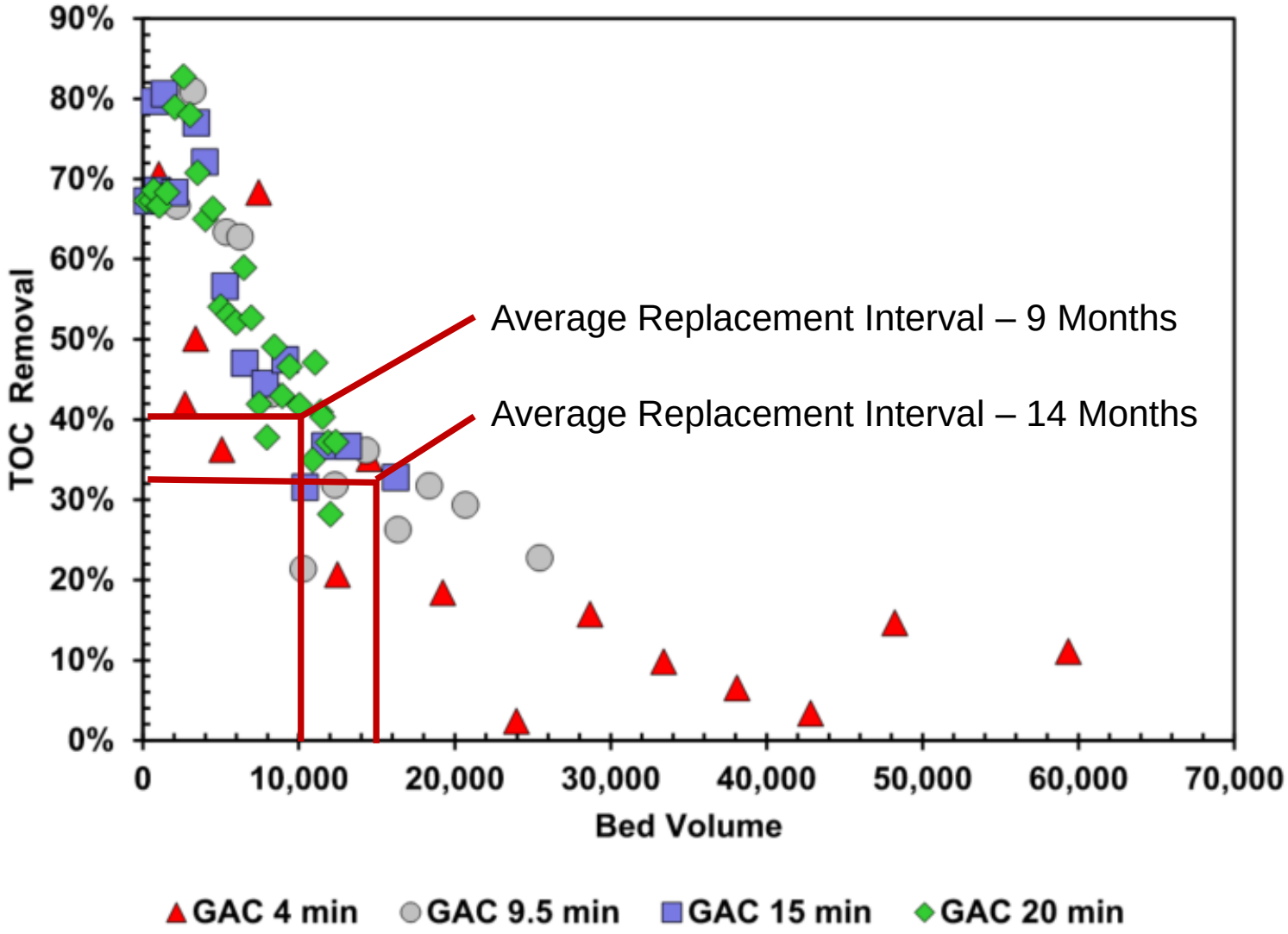
TOC Removal of GAC Contactor

Target Bed Volumes & Replacement Intervals can be increased with additional TOC removal following upcoming WTP Improvements



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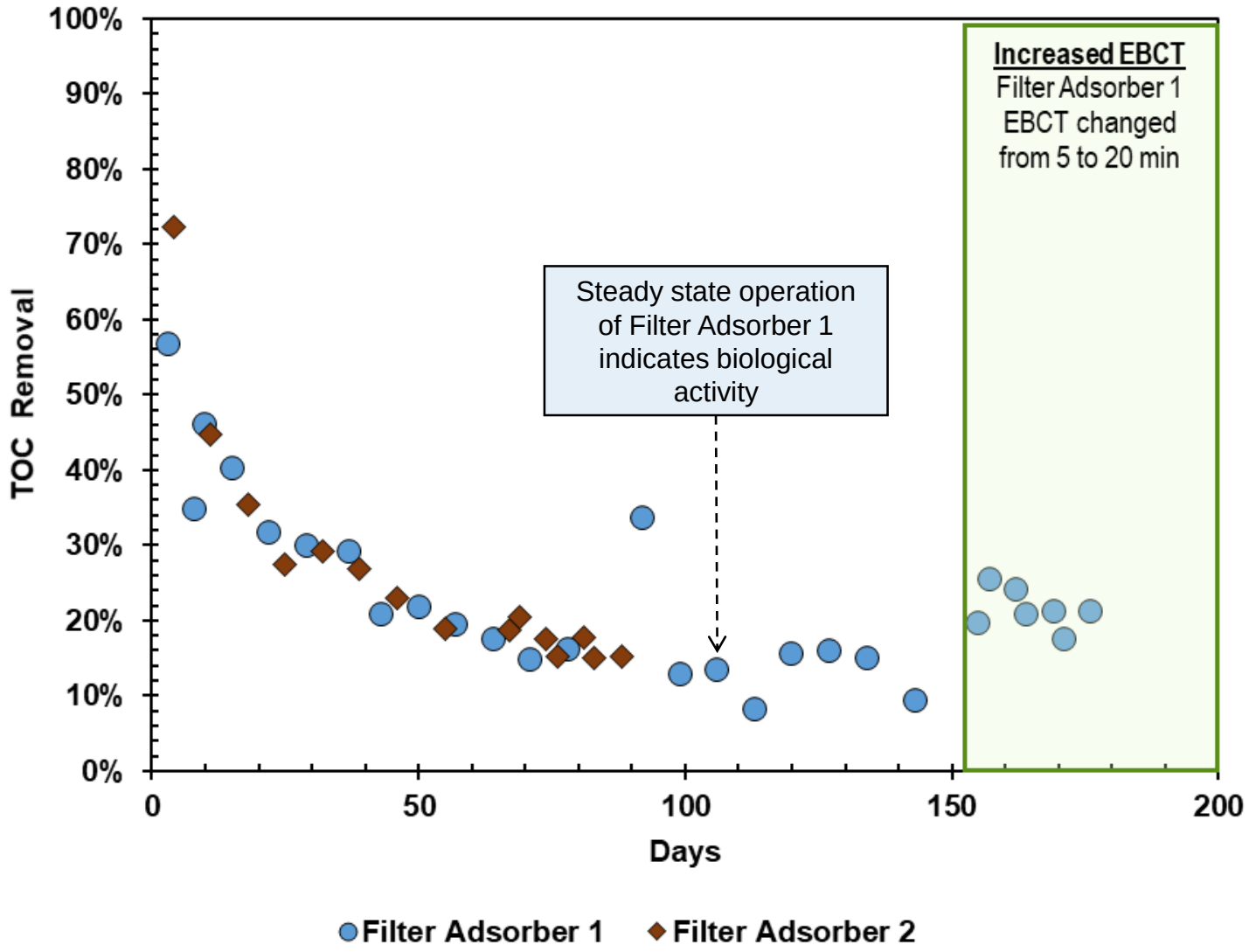
TOC Removal of GAC Filter Adsorber



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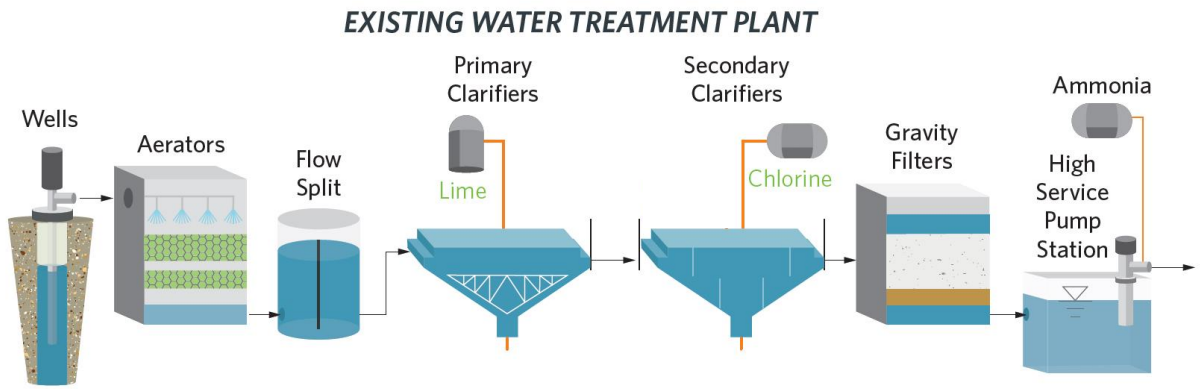
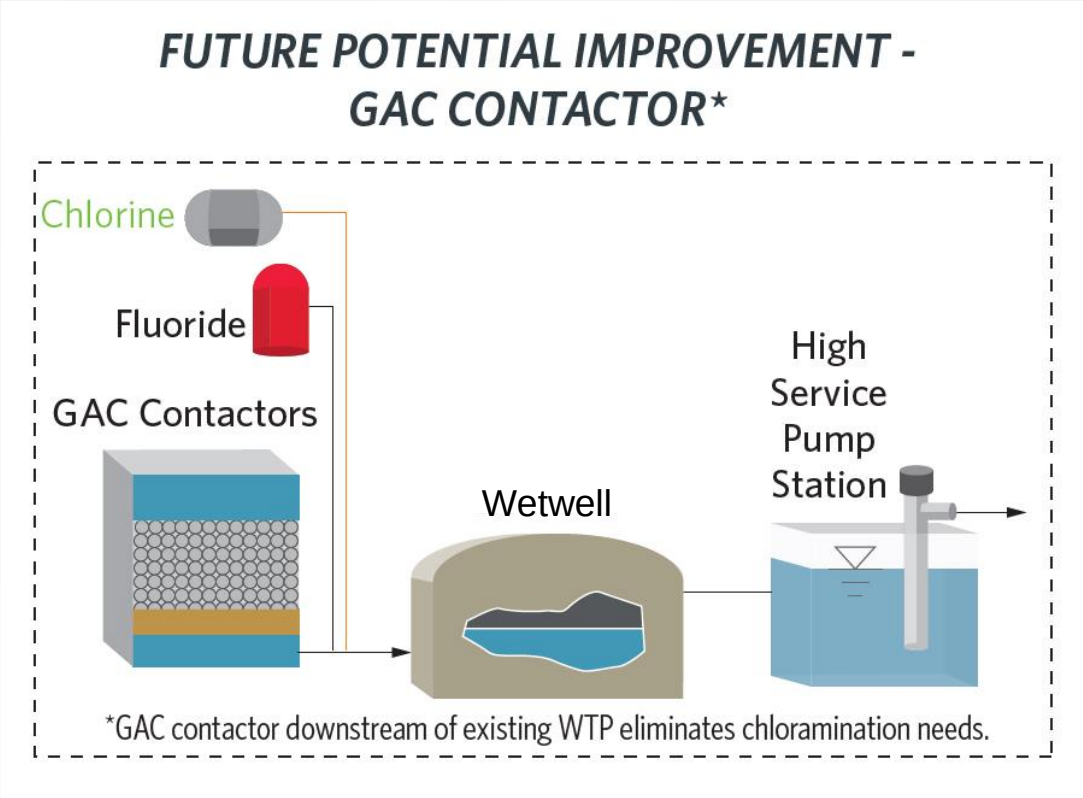
GAC Contactor Recommended Alternative for Free Chlorine Primary Disinfection





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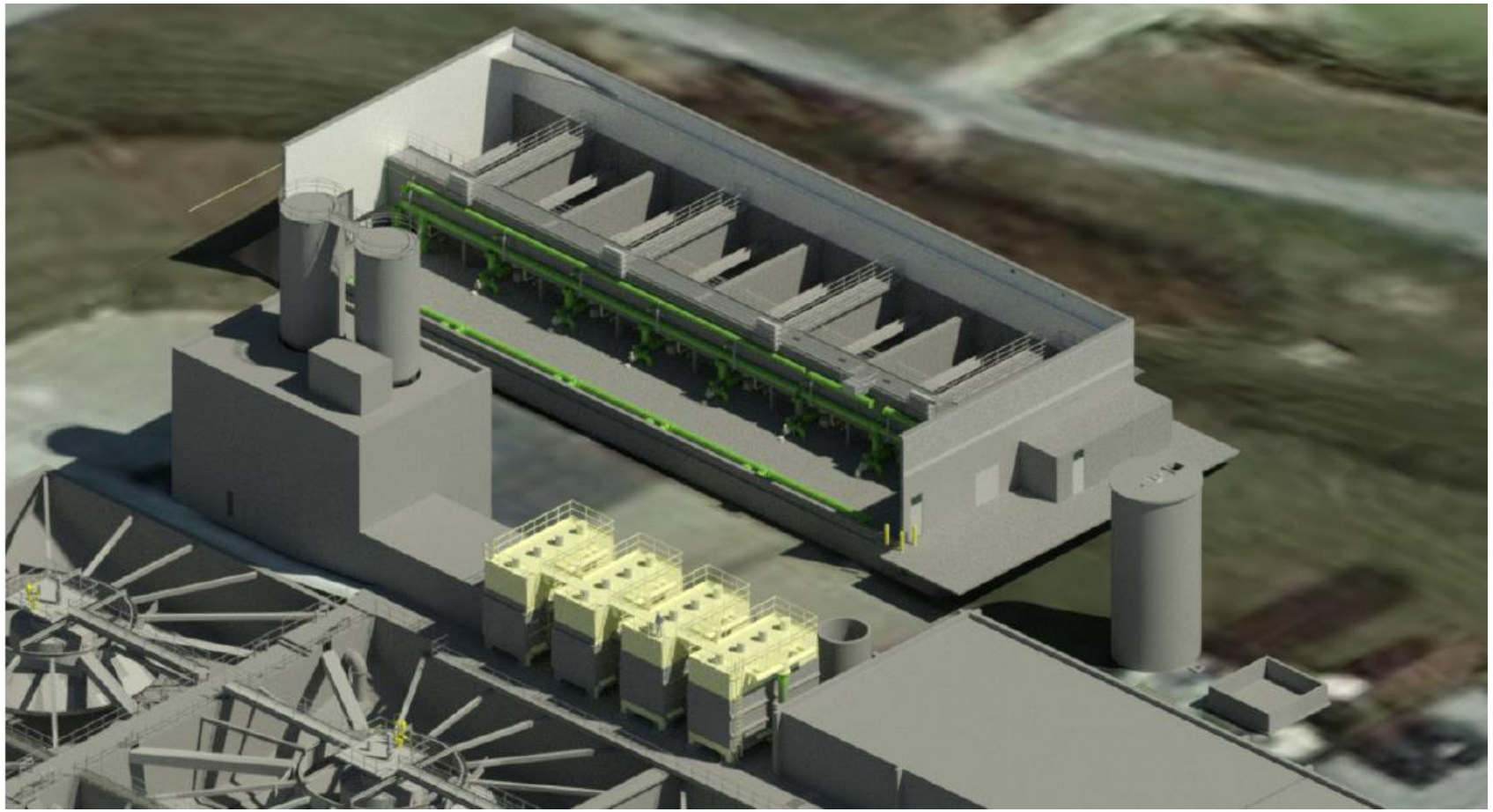
GAC Contactor Recommended Alternative for Free Chlorine Primary Disinfection



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Opinion of Probable Cost for GAC Contactor

Total Class 5 Construction Cost Estimate	$46,700,000
Class 5 Range Low (-15%)	*$39,700,000*
Class 5 Range High (+25%)	*$58,400,000*

Item	Cost ($)
Annual GAC Replacement Cost	$2,670,000 - $4,160,000
Annual Power Cost	$20,000
Total Annual Operating Cost	$2,690,000 - $4,180,000
20 year Present Worth	$98,700,000 - $127,300,000

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Pilot Study and Alternatives Analysis Conclusions

- GAC contactors recommended for free chlorine disinfection based on current treated water quality
- DBP water quality goals significantly impact life-cycle costs
- Current WTP improvements may improve removal of DBP precursors (TOC)
- Improved TOC removal may reduce GAC life-cycle costs
- Biologically active filtration may be a future option depending on full-scale TOC removal

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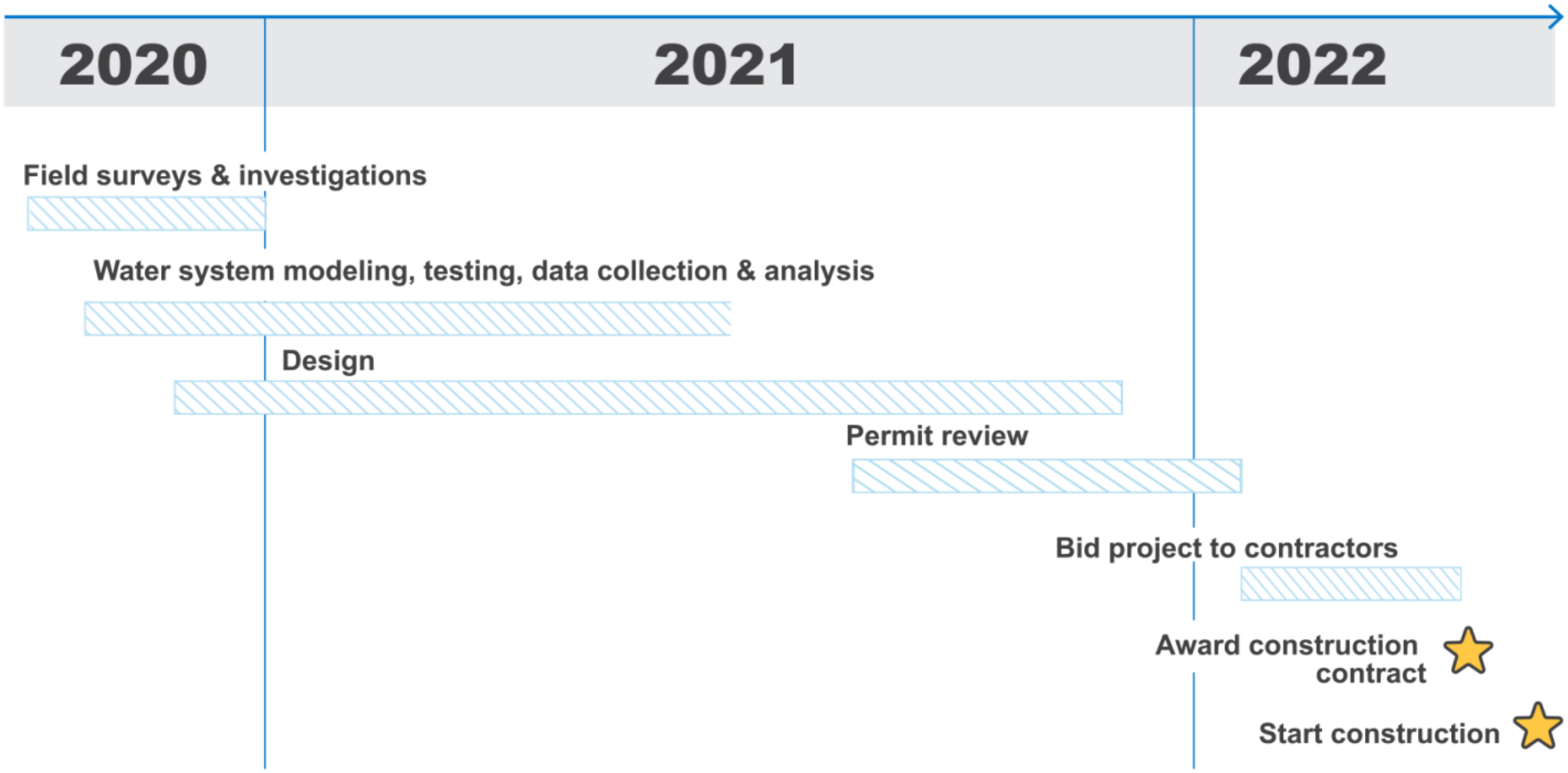
Project Schedule (Current Improvements)



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Engagement Opportunities

como.gov/utilities/mcbaine-wtp-project/

@ColumbiaWaterLight

573.874.CITY (2489)

WLmail@CoMo.gov

Virtual meeting dates TBD

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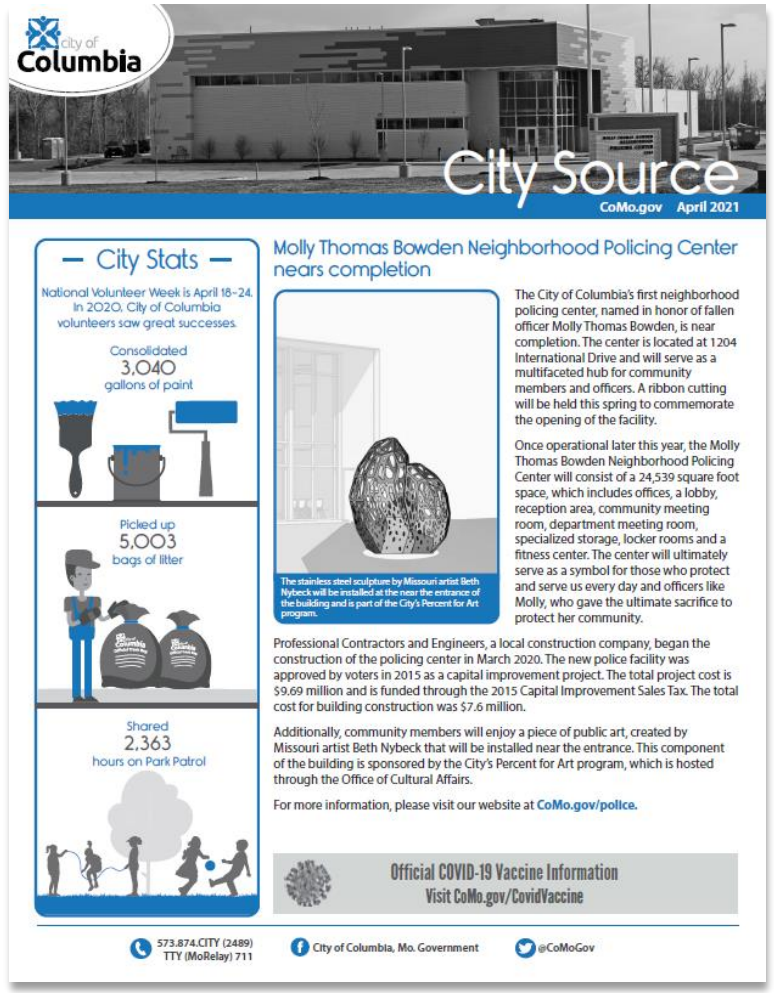
Thank You



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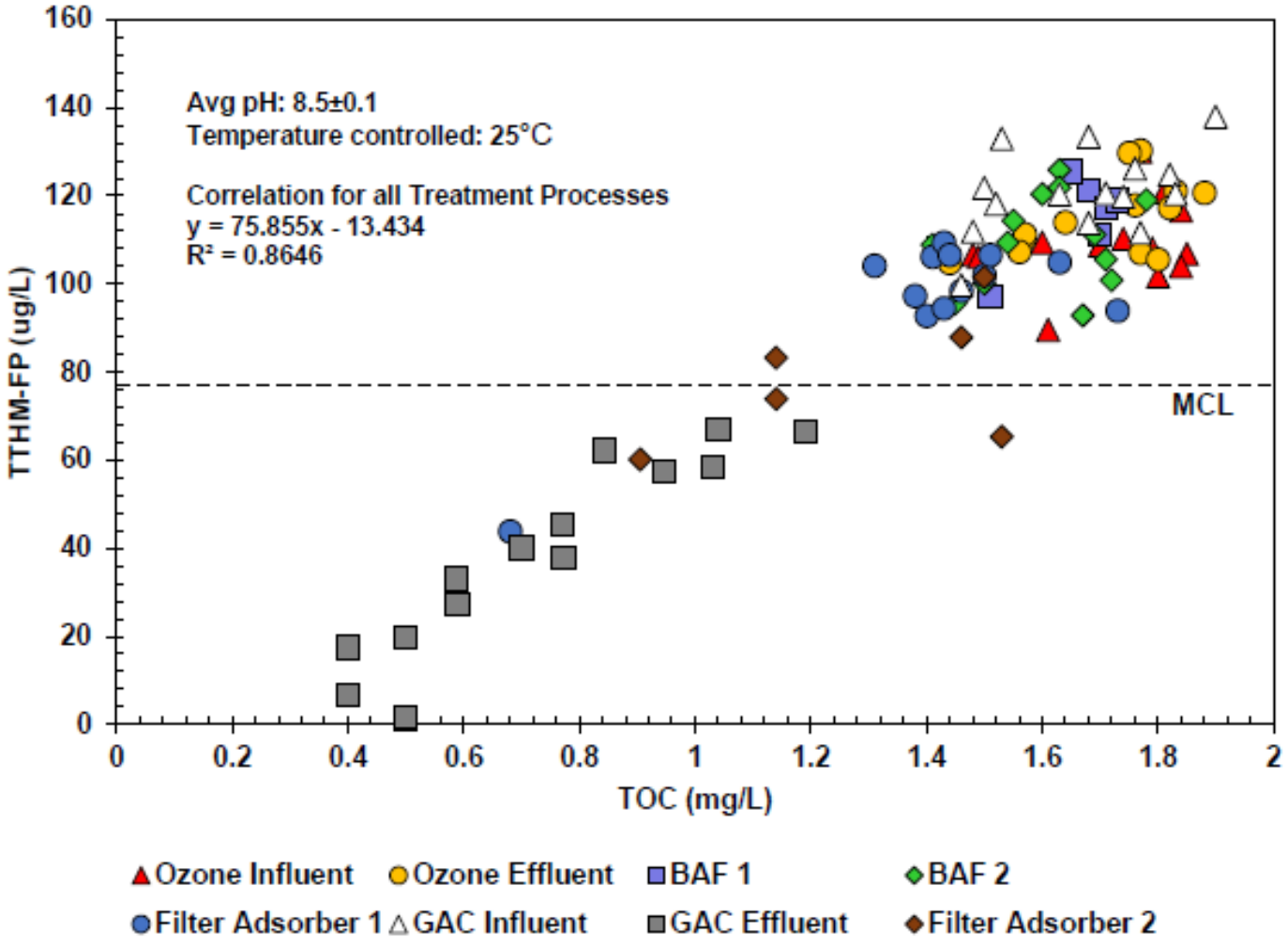
Correlation between TTHM Formation Potential and Total Organic Carbon



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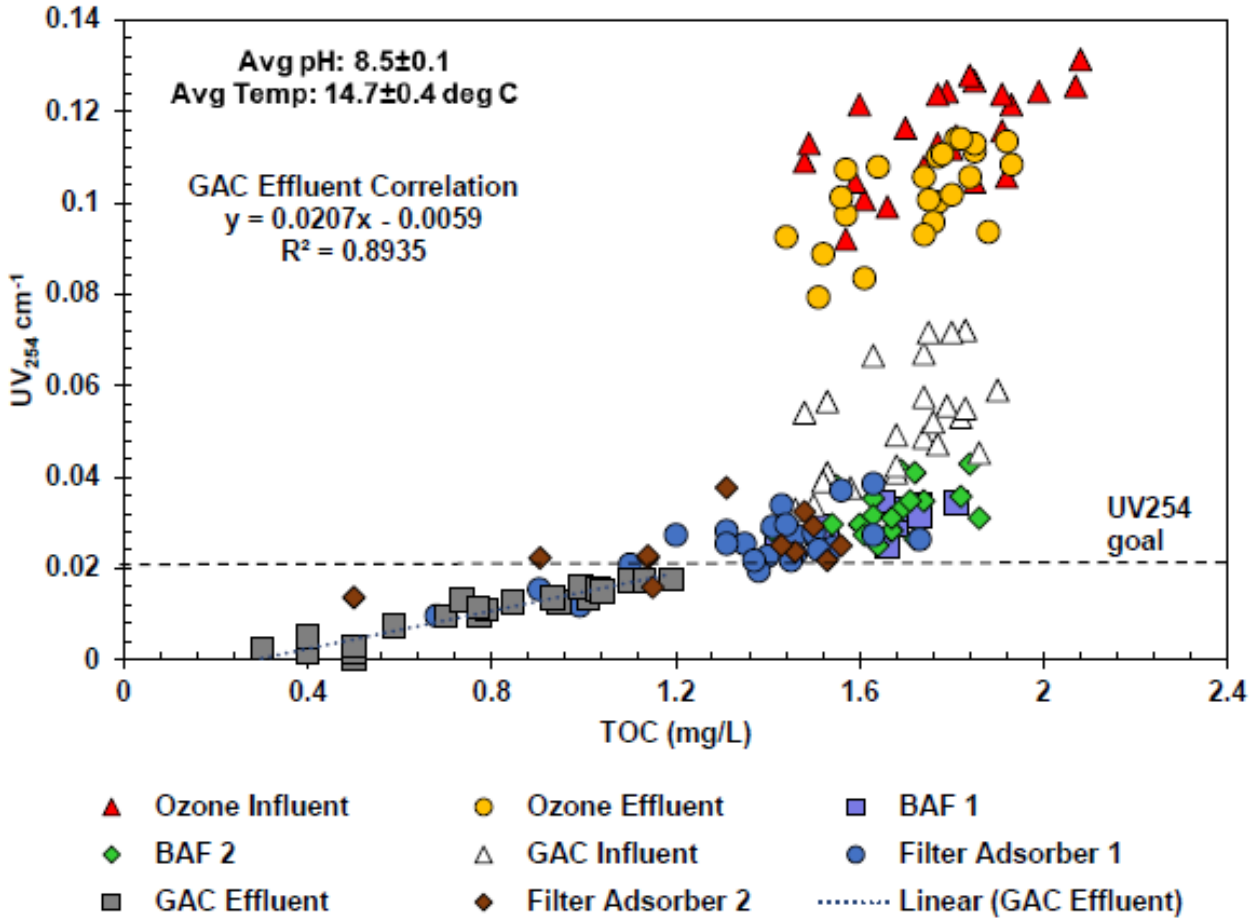
Correlation between Total Organic Carbon and UV_{254} Absorbance



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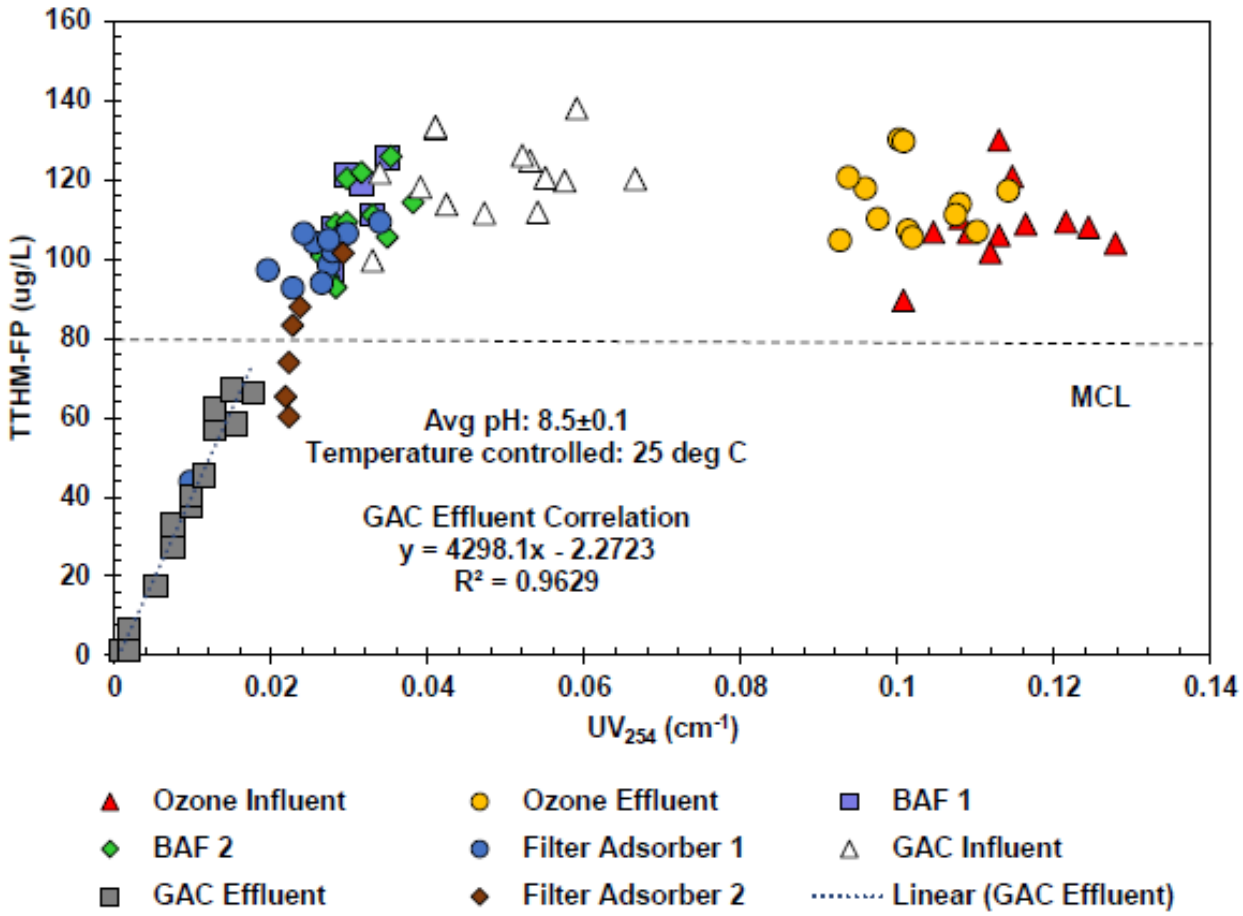

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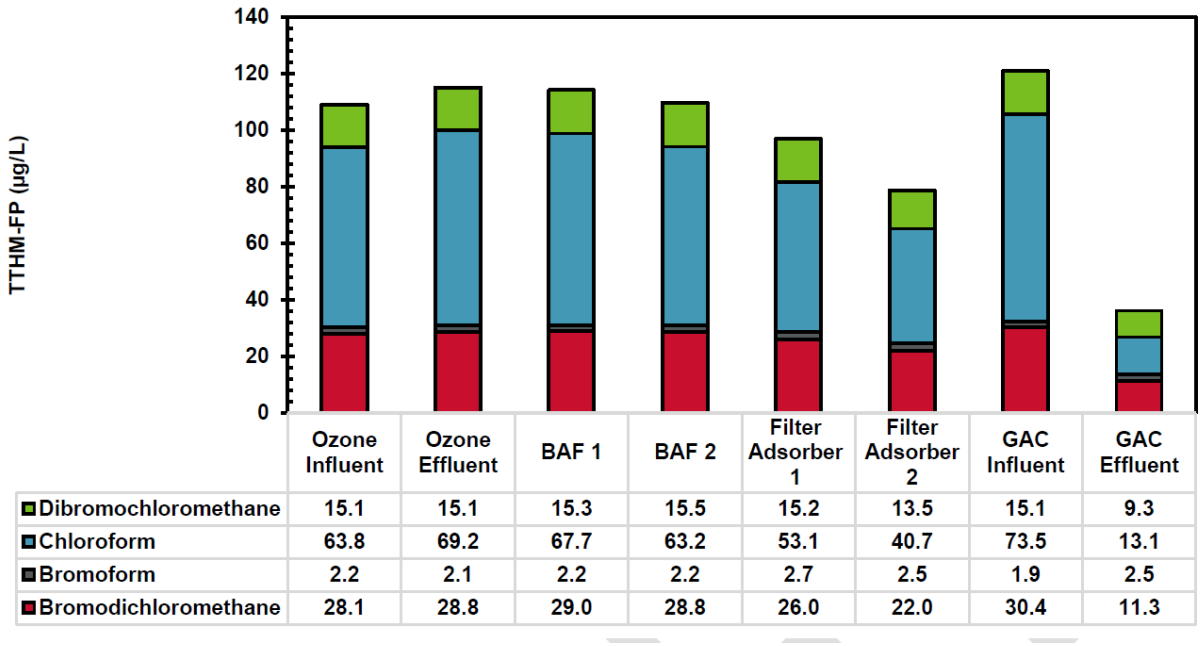
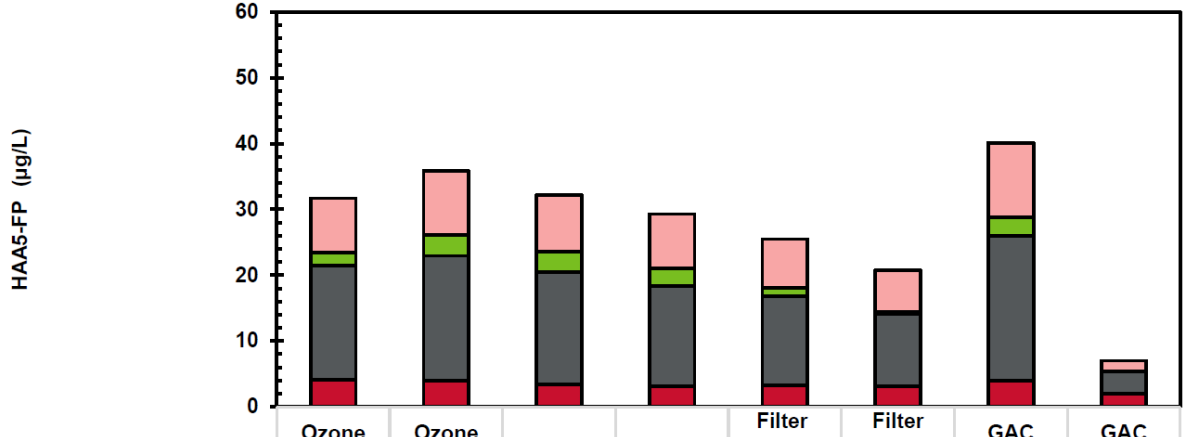
DBP Speciation



	Ozone Influent	Ozone Effluent	BAF 1	BAF 2	Filter Adsorber 1	Filter Adsorber 2	GAC Influent	GAC Effluent
Dibromochloromethane	15.1	15.1	15.3	15.5	15.2	13.5	15.1	9.3
Chloroform	63.8	69.2	67.7	63.2	53.1	40.7	73.5	13.1
Bromoform	2.2	2.1	2.2	2.2	2.7	2.5	1.9	2.5
Bromodichloromethane	28.1	28.8	29.0	28.8	26.0	22.0	30.4	11.3

Total Trihalomethanes



	Ozone Influent	Ozone Effluent	BAF 1	BAF 2	Filter Adsorber 1	Filter Adsorber 2	GAC Influent	GAC Effluent
Trichloroacetic acid	8.3	9.7	8.6	8.3	7.5	6.3	11.3	1.6
Monochloroacetic acid	1.9	3.2	3.1	2.6	1.2	0.4	2.8	0.0
Monobromoactic acid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dichloroacetic acid	17.4	19.0	17.1	15.3	13.5	11.0	22.0	3.5
Dibromoacetic acid	4.1	3.9	3.4	3.1	3.3	3.1	4.0	1.9

Haloacetic Acids

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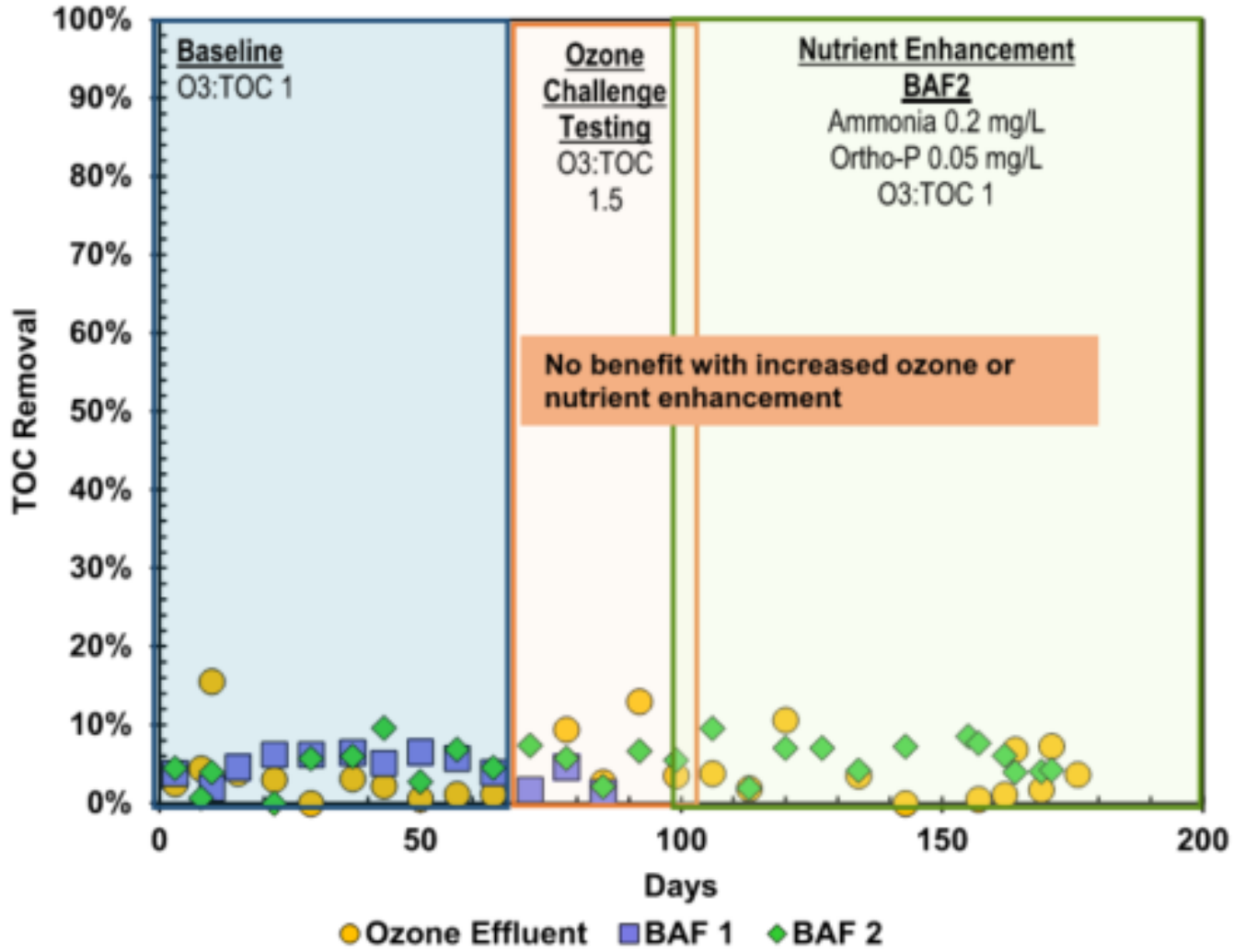
TTHM Formation Potential of Ozone/Biofiltration Effluent



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Potential Water Quality Goals with Free Chlorine Primary Disinfection

TTHM (ug/L)	TOC (mg/L)	UV_{254} (cm^{-1})	GAC Bed Volumes
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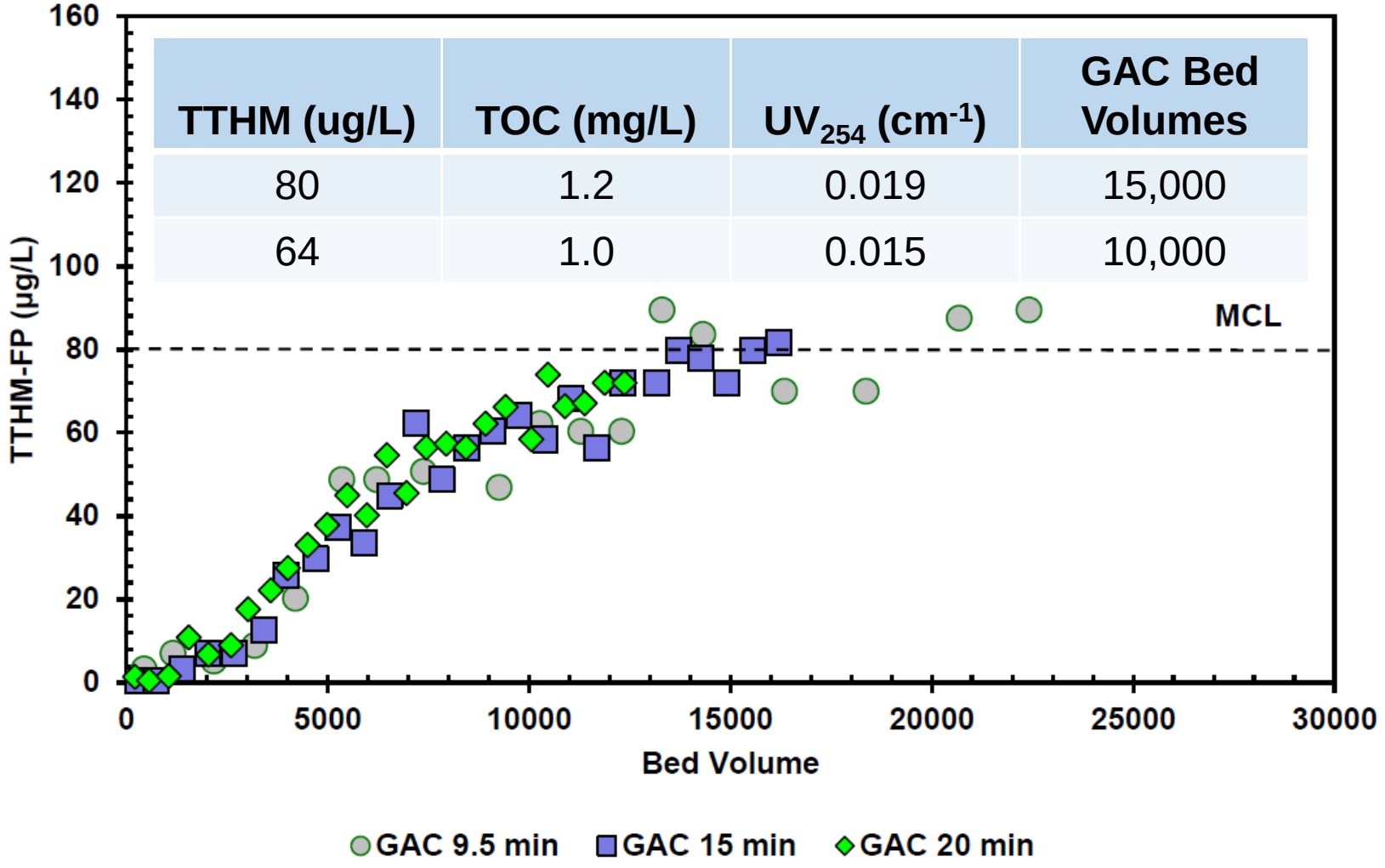
64	1.0	0.015	10,000



Calculated based on TTHM and UV_{254} correlation

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